INTERNATIONAL

ElectronicDesign

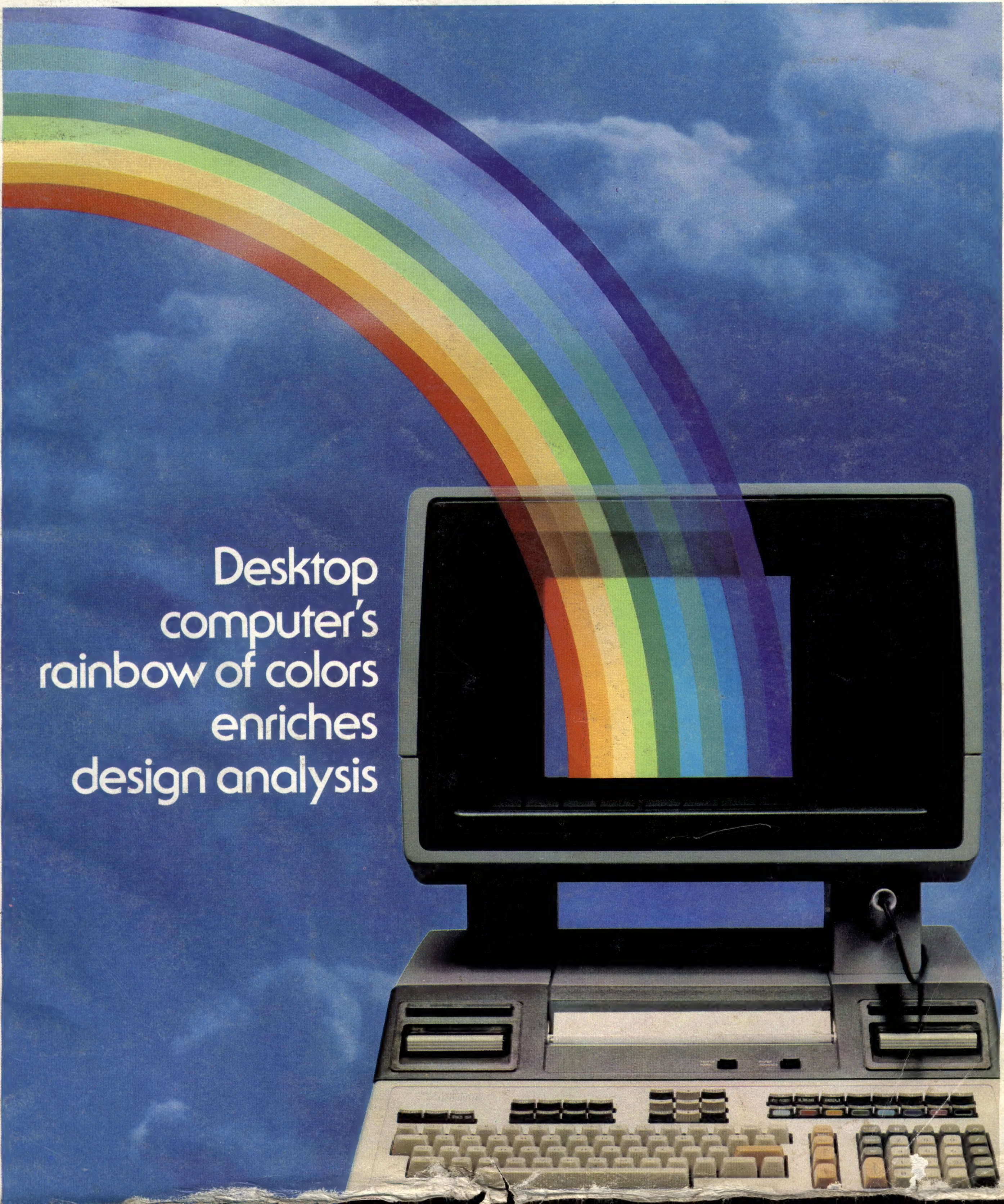
FOR ENGINEERS AND ENGINEERING MANAGERS—WORLDWIDE

MAY 10, 1980

Special Computer Issue:
Systems design hinges on buses, architectures

NCC in Anaheim—software, data nets and supercomputers

Special Report:
Winchesters spin out low-cost storage



Desktop computer's rainbow of colors enriches design analysis

With Panasonic battery systems the memory lingers on.

The next time you need a battery system for biasing, to hold memory, or for shutdown power protection, look to Panasonic.

Panasonic offers you more types of batteries than anyone in the industry. Within our selection of characteristics, sizes, and prices, you can meet voltage requirements anywhere from 2.0V to a full 24V. And get precisely the energy support you need—for extremely low drain devices for CMOS biasing all the way up to systems for computer program transfer and hold-memory storage. (For that matter, if you need orderly shutdown of process controls, we'll set you down v-e-r-y easy.)

We can meet your cost configuration requirements, too. Panasonic offers a choice ranging from miniature batteries that are pin-compatible with PC-board mounts, to much larger types with soldered permanent connections. All give you the Panasonic plus of 100%-tested uniformity. And all are conservatively rated to give you power to spare.

For a minicatalog showing standard battery types and sizes, including new "Memory-Mount"™ models, or specific product information, write or call: OEM Battery Dept., Panasonic Company, Electronic Components Division, One Panasonic Way, Secaucus, NJ 07094; phone (201) 348-7277 or (201) 348-7278.

See Us at booth #1239

CIRCLE NO. 131

For build-up or back-up, we've got your battery.

Typical Memory/ Shutdown Drain	Energy Systems	Size Ranges (Cap. Avail.)	Applications
½μA-50μA	MINIATURE: Lithium Mercury Alkaline Sealed nickel Cadmium	20 MAH-500MAH	CMOS, microprocessors & microcomputer hold-memory Tuner circuits
50μA-50MA	MID-SIZE: Lithium Alkaline Mercury cylindrical cells Nickel cadmium Lead acid	500MAH-1.2AH	LSI types (micro-computers, minicomputer memory, P.O.S. pre-programmed products)
50MA-400MA	LARGE: Lithium Mercury Nickel cadmium Lead acid	1.5AH-7.5AH	Software memory transfer and hold Alarm & security back-up Industrial controls
400MA-20A	LARGE: Nickel cadmium Lead acid	5AH-7.5AH	Computer software transfer & hold memory Power maintenance for orderly shutdown of industrial controllers Static inverter back-up

Panasonic®
just slightly ahead of our time

LETTER FROM THE EDITOR

About our new look...

As one of your primary sources of design information, Electronic Design knows how important it is to convey that information as concisely and quickly as possible. To speed the information flow, we have redesigned and streamlined the magazine, from cover to cover, employing contemporary graphics that keep pace with the fast moving electronics industry.

You'll find our headlines shorter and larger, making it easier for you to scan our pages and pick the stories you want to read. A short summary right above the headline of each principal article should also help speed your decision. Wider margins and greater use of white space make the pages themselves easier to read. And the editorial copy on every page has been moved out from the binding of the magazine, so that you don't have to grope for words that curve away.

Our new cover design offers enhanced readability. The title for the story on the cover is now the only copy on the picture area itself. Our secondary cover lines are removed from the picture area and printed on a white background. This new location not only makes them easier to read but also prevents them from being totally or even partially blocked by your mailing label.

The revamped table of contents now lays out the entire issue for viewing at a single glance. As always, we are providing a complete listing of every news and product feature in the issue, as well as every design article. But instead of highlighting the most important design articles on a separate page, we've coupled an expanded summary of the article with its title.

In our design section, each article now carries a label (in the upper lefthand corner of a page) that helps you identify stories as you turn the pages. In addition, because we are proud of the engineers who write our design articles, we are displaying their bylines more prominently.

We are also introducing a new feature, the Publisher's Memo, which will bring you a behind-the-scenes view of Electronic Design -- its special reports, its special issues, its editorial staff and its authors. Another new feature is our Meetings department, a compilation of the most important technical conferences -- and their dates -- in the electronics industry.

Our new look also entails a number of other changes, like a revamped Editorial page and straight simple labels for our major sections and department headings -- Late News, News, Design, Products, Meetings and Letters.

We believe that our new look will make Electronic Design even more valuable to you. Now take a look for yourself and see what we mean.

Lucinda Mattera

Lucinda Mattera
Editor

It gets tougher all the time. Trying to match budget dollars with instrument performance can be a real problem. Unless the instrument is our Model 1062 Sweeper.

At only $890,* the Model 1062 is a full-performance laboratory sweeper with a 1-400 MHz frequency range. You can sweep any portion of that range at variable rates, and have triggering capability to boot. You'll also find 10 mW RF output, 2% sweep linearity, and ±0.25 dB flatness—performance characteristics usually seen only on much more expensive instruments.

The Model 1062 also includes provision for an optional crystal-controlled birdy bypass marker system. Up to six plug-in marker modules may be added. The markers can be at single discrete frequencies or they can be harmonically related. Front-panel controls vary marker amplitude and bandwidth.

Get the sweeper that solves budget and performance problems all at once. Get the Model 1062—still only $890.*

Wavetek Indiana, P.O. Box 190,
66 North First Ave., Beech Grove,
IN 46107. Toll free 800-428-4424;
in Indiana (317) 783-3221.
TWX (810) 341-3226

WAVETEK®

*U.S. price only

For Demonstration Circle No. 2

For Literature Circle No. 3

Get rid of sweeper budget problems.

Get our budget sweeper.

ElectronicDesign
May 10, 1980 • Vol. 28 No. 10

Departments

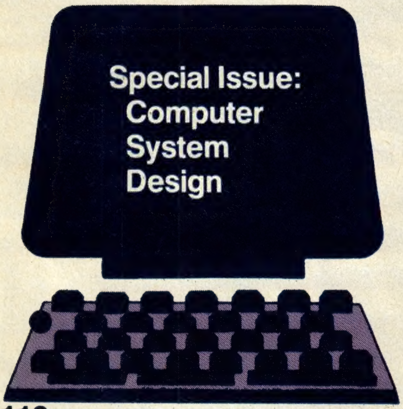
7 Publisher's Memo
11 Editorial
15 Letters
17 Meetings
373 Your Profession
398 Index of Advertisers
400 Reader Service Card

News

27 Late News
35 LSI processor (the 8087) speeds floating-point calculations.
37 Interactive Pascal enhanced with "lazy input."
37 Better control of GaAs impurities means better devices.
39 Phase-locked loop stabilizes signal generator.
39 Laser interferometer cuts IC line widths.
42 Speech recognition speeds data entry.
42 Losses can be cut to 0.15 dB in fiber-optic splices.
49 Washington Report
54A International section

Technology

65 Special Report: Winchester-disk drives step up capacity and performance.
81 NCC '80 sessions herald software, data nets.
95 NCC '80 product preview—12 show-stoppers.
113 Special report on computer-system design: Which μC, bus and development tools?
115 System performance hinges on architecture...
125 ...But the right bus evokes the system's best.
133 Facile support chips free up the host CPU...
141 ...While development tools support many users.



113

Design

161 Desktop computer colors graphics (cover).

The HP System 45C enhances information flow with high-resolution graphic displays—in 4913 shades of color.

169 Six chips expand interface options.

Communication between a CPU and I/O devices on a multiplexed data/address bus depends on the interface. Six chips can work with the user's logic to form a custom interface for the LSI-11 bus.

179 Winchesters set fast pace for controller designers.

Because low-cost, 14-in. Winchester drives can transfer data ten times faster than floppies, the first criteria for building a controller—and for selecting each of its components—is speed.

187 Big-system protocol boosts small system.

A mainframe-communications protocol, when adapted to micro or minicomputers, cuts the overhead plaguing data transfers between CPU and disk units while increasing performance.

199 Cartridge-drive system suits Winchester backup.

Winchester-disk backup should be low-cost, compact and reliable; all three come together in a high-capacity cartridge drive.

161

205 Fast raster-scan displays graphics and images.

Besides dual-processor/dual-bus architecture for optimum throughput, a raster-scan display brings together a host of transformation features for analyzing graphic images.

213 Smart terminals fit special applications.

μP-based smart terminals come "factory-programmed" to perform certain operations. But there's much more capability built-in—and the system designer can make the modifications.

219 Bootstrap lets Multibus tap CP/M-based software.

A two-card system replaces the complicated hardware formerly required to use Multibus boards with CP/M software.

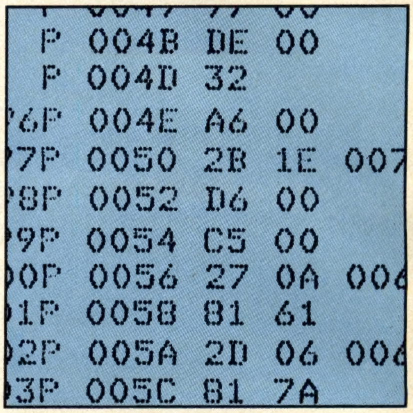
227 TI-59 analyzes complex ladder networks.

Nine-branch ladder networks with complex elements yield to a calculator program based on a matrix method. The program lets the TI-59 handle a task once reserved for large computers.

233 Calculator program speeds 32 FFT points.

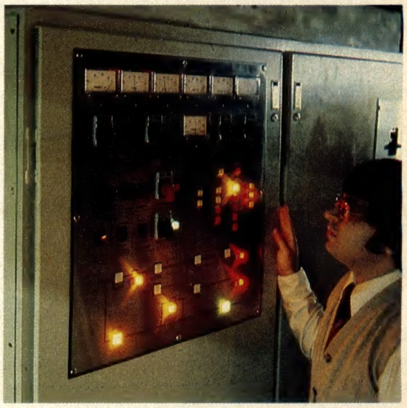
A fast-Fourier-transform program—adapted from the Cooley-Tukey algorithm—runs on a TI-59 programmable calculator.

239 Ideas for Design



```
 P 004B DE 00
 P 004D 32
6P 004E A6 00
7P 0050 2B 1E 007
8P 0052 D6 00
9P 0054 C5 00
0P 0056 27 0A 00
1P 0058 81 61
2P 005A 2D 06 00
3P 005C 81 7A
```

213



251

Products

251 **Focus on uninterruptible power supplies.**
267 **Subassemblies:** 'Super' switcher delivers 3 W/cu in.
268 Color monitors provide good resolution, low price.
271 Power modules offer TTL compatibility.
272 10-A, 150-W regulator—small but protected.
281 **Instruments:** 16-lb, 100-MHz scope displays four traces.
288 **Microsystems:** 8086 system serves multiusers, tasks.
295 Faster memory speeds PROM emulator.
296 Display assemblies interface easily.
305 **Components:** Precision resistors move up to 250 kΩ.
306 Trimmers make stronger, lower-cost contacts.
310 **Digital Circuits:** 4-bit μC packs display controller.
315 **Peripherals:** Bubbles pack storage, speed in cassettes.
318 Emulator simulates four CRT terminals.
324 **Communications:** Silica-core cable bends without breaking.
326 Detector combines sensitivity, speed.
332 **Analog Circuits**
349 **Computers**
352 **Packaging & Production**
366 **Application Notes**
368 **New Literature**

Coming in the May 24 issue:

Focus on pots and trimmers ... Introducing a major new microcomputer ... First details on a milestone fiber-optic component ... How to design a smart terminal ... Building fast 64-k RAM boards.

Cover: The HP System 45C desktop computer; photo courtesy of Hewlett-Packard.

125,263 copies of this issue printed.

ELECTRONIC DESIGN (USPS-172-080) is published biweekly except 3 issues in July by Hayden Publishing Company, Inc., 50 Essex St., Rochelle Park, NJ 07662. James S. Mulholland Jr., President. Printed at Brown Printing Co., Waseca, MN. *Controlled* circulation postage paid at Waseca, MN, and New York, NY. Postage pending Rochelle Park, NJ.
Copyright © *1980*. Hayden Publishing Company, Inc. All rights reserved.
POSTMASTER: Please send form 3579 to ELECTRONIC DESIGN, P.O. Box 13803, Philadelphia, PA 19101.

Get 1 watt output from your H-P generator with a Mini-Circuits amplifier!

0.05 - 1000 MHz
from $199

Need more than the 10 mw available from your signal/sweep generator or synthesizer for system and subsystem testing?

Just add a Mini-Circuits' ZHL wideband amplifier and boost the 10 mw level to 1 watt or +30 dBm. Also, there's an additional benefit ... as much as 40 dB isolation will be added between the generator and the system under test. And VSWR is less than 2:1 over the full frequency range.

Upgrade your present generator now ... check the specs and low prices below and order your ZHL wideband amplifier today ... and we will ship within one week!

MODEL NO.	FREQ. MHz	GAIN dB	GAIN FLATNESS dB	MAX. POWER OUTPUT dBm 1-dB COMPRESSION	NOISE FIGURE db	INTERCEPT POINT 3rd ORDER dBm	DC POWER		PRICE	
							VOLTAGE	CURRENT	$ EA.	QTY.
ZHL-32A	0.05-130	25 Min.	±1.0 Max.	+29 Min.	10 Typ.	+38 Typ.	+24V	0.6A	**199.00**	**(1-9)**
ZHL-3A	0.4-150	24 Min.	±1.0 Max.	+29.5 Min.	11 Typ.	+38 Typ.	+24V	0.6A	**199.00**	**(1-9)**
ZHL-1A	2-500	16 Min.	±1.0 Max.	+28 Min.	11 Typ.	+38 Typ.	+24V	0.6A	**199.00**	**(1-9)**
ZHL-2	10-1000	16 Min.	±1.0 Max.	+29 Min.	18 Typ.	+38 Typ.	+24V	0.6A	**349.00**	**(1-9)**
ZHL-2-8	10-1000	27 Min.	±1.0 Max.	+29 Min.	10 Typ.	+38 Typ.	+24V	0.65A	**449.00**	**(1-9)**

Total safe input power +20 dBm, operating temperature 0° C to +60° C, storage temperature −55° C to +100° C, 50 ohm impedance, input and output VSWR 2.1 max. For detailed specs and curves, refer to 1979/80 MicroWaves Product Data Directory, p. 364-365 or EEM p. 2970-2971.

World's largest manufacturer of Double Balanced Mixers

Mini-Circuits

MINI-CIRCUITS LABORATORY
A Division of Scientific Components Corp.

2625 East 14th Street Brooklyn, New York 11235 (212) 769-0200
Domestic and International Telex 125460 International Telex 620156

R45/Rev/C

CIRCLE NO. 4

ElectronicDesign

Editor: Lucinda Mattera

Executive Editors: Stephen E. Scrupski, Stanley Runyon

Managing Editor: Michael Riezenman

Executive Art Director: Thomas Phon

Senior Editors: David Bursky, Morris Grossman, Sidney Adlerstein

Technology Editors:
Analog Circuits & Components: Stephan Ohr
Circuit Design & Professional: Donald Mennie
Communications: Sidney Adlerstein
Computers & Peripherals: Leonard Yencharis
Instruments: Jonah McLeod (Sunnyvale)
Packaging & Power: Morris Grossman
Semiconductors: David Bursky (Sunnyvale)
Software & Systems Integration: Max Schindler

Field Editors:
New York: Eugene Heftman
Los Angeles: Ron Shinn

New Products Editor: Harold Winard

Staff Writers: James Keane, Sharon Bailly

Editorial Production:
Manager: Marjorie Duffy
Assistant: Edward Connolly

Art Director: William Kelly
Assistant: Anthony J. Fischetto
Illustrator: Thomas Blaine

Editorial Offices:
50 Essex St., Rochelle Park, NJ 07662
(201) 843-0550, TWX: 710-990-5071
(HAYDENPUB ROPK)
Cable Haydenpubs Rochellepark

West Coast: 1307 S. Mary Ave., Suite 212
Sunnyvale, CA 94087. (408) 736-6667

8939 S. Sepulveda Blvd., Suite 414
Los Angeles, CA 90045. (213) 641-6544
TWX-1-910-328-7240

Sales Managers:
Eastern: Thomas Barth
Western: Robert Lukas

Business Manager: Thomas E. Vachon

Promotion Manager: Donald Hawes

Marketing Manager: Jay McSherry

Advertising Production:
Manager: Edward J. Grimm
Assistants: Paul InCalcatera, Frank Murphy, Sharon Roden

Circulation Director: Barbara Freundlich
Senior Assistant: Gail Stone

Reader Service: Paula Greenleaf

Reprints: Maxine Sassano

Publisher: Laurence Altman

Publisher'sMemo

The computer field is so diversified—blanketing mainframes, memory systems, software, development tools, disk drives, CRT terminals, peripheral controllers—that no one editor could report adequately on the entire field. For this special issue on computer systems design, Electronic Design assembled a five-person editorial team to tackle the task. The package they have put together is indeed a formidable one—encompassing no less than seven staff-written special reports and eight design articles bylined by experts in the computer field.

It is fortuitous that this computer special issue also introduces a new look for Electronic Design. What better editorial vehicle for our contemporary graphics than computers?

The special report on Winchester disk drives sums up and forecasts the latest developments in this fast-moving technology. Similarly, our special report on the National Computer Conference previews the software and supercomputer architecture to be discussed in the technical sessions and focuses on a dozen of the hot new products to be introduced on the exhibition floor.

Like our NCC coverage, the staff-written computer special reports showcase the talents of our editors. Max Schindler, Software & Systems Integration Editor, evaluates the ins and outs of CPU architecture; Len Yencharis, Computer & Peripherals Editor, digs into the multifaceted personalities of the most popular bus structures; Dave Bursky, Semiconductors Editor, examines the power of newly emerging CPU support chips; Jonah McLeod, Instruments Editor, assesses the systems used to develop software; and Morris Grossman, Packaging & Power Editor, reports on the computer's often-overlooked but indispensible companion—the uninterruptible power supply.

Each of our eight design articles targets a particularly timely aspect of computer systems design. The articles are as diversified as the computer field itself, beginning with the new Hewlett-Packard desktop color computer (highlighted on our cover); the application of raster-scan technology in a CRT display terminal for both graphics and imaging; and a cartridge disk drive that provides up to 75 megabytes of storage.

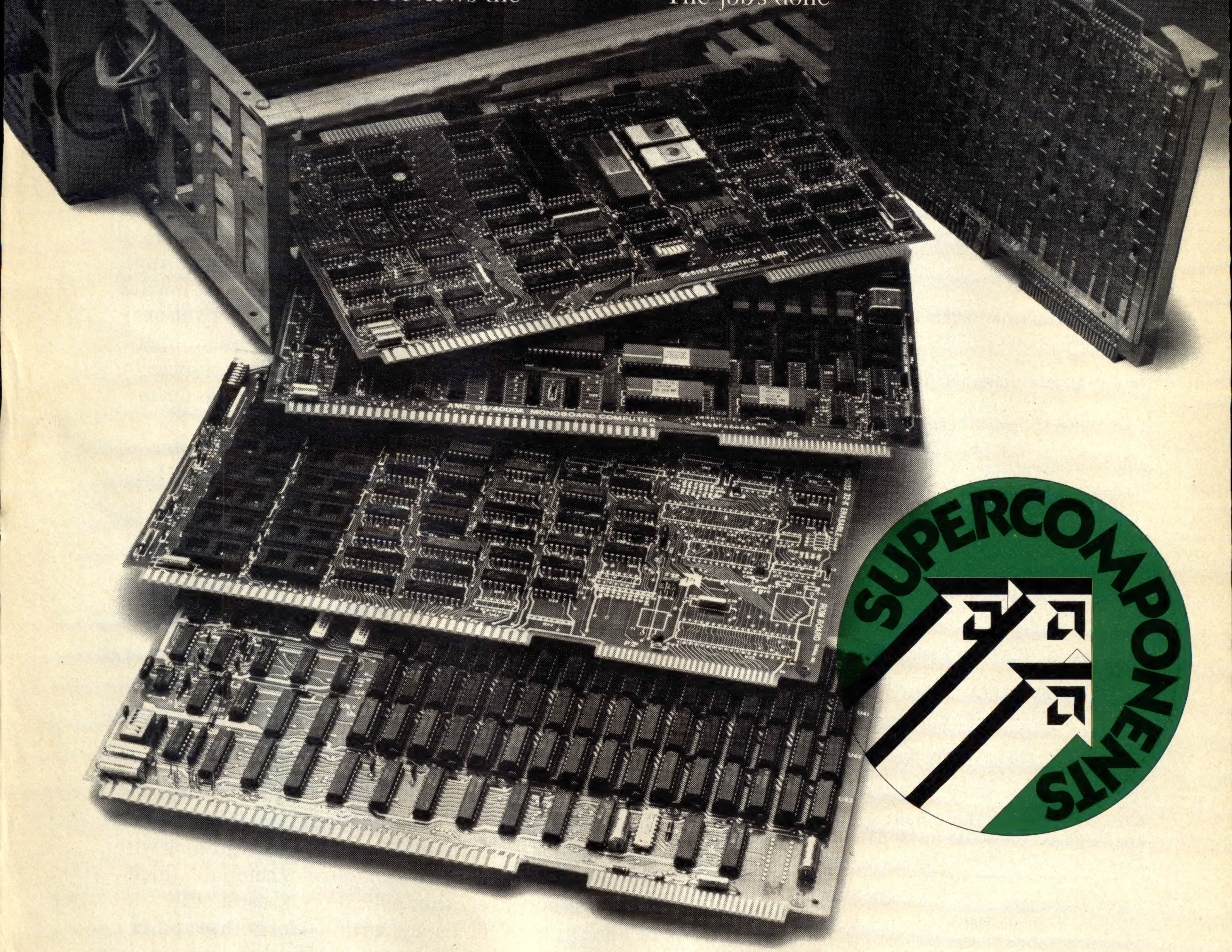
This is a very special issue on computer systems design—one that Electronic Design is proud to bring to you.

Larry Altman

A process-control engineer wants a high-speed, low-cost computer to monitor and control a factory operation. He checks out the Supercomponent™ specs and moves on to the next project. This job's done.

A systems engineer is designing a blood analyzer on a really tight schedule. He needs a digital controller to record, analyze, compare, file and retrieve data. He reviews the Supercomponent technical manual, then moves on. The job's done.

A systems designer wants to control a radar telemetry system. There are special software considerations, and real-time data is needed. (Last year, a design just like it took him six months.) He spends a couple days with Supercomponent specifications and moves on. The job's done



Here come the Supercomponents!

Advanced Micro Devices announces a family of LSI-intensive boards built to save the serious systems designer a whole lot of time and money. Supercomponents are changing the make-or-buy rules. Here's why:

They're absolutely state of the art. They are designed-in like components and they think like VLSI. They save you a ton of interface design time. They're plug-in ready. All are iSBC80* compatible and have a Multibus.* And, of course, we have all the enclosures and power supplies and card cages and back planes and software you need to cut your costs and accelerate your project.

Now for the big reason: Supercomponents are better because the parts are better. They're made from the finest, freshest, most advanced LSI in the business.

You picked a terrific time to be in this business. Supercomponents are here.

The Am95/4005.

Our single-board computer, The Monoboard,™ is very powerful. It has all the features others in its class have, but—over and above—it includes a sophisticated arithmetic processor, four DMA channels and speeds up to 4 megahertz!

The Am95/6110.

Our floppy disk controller has its own built-in intelligence. It has its own Am8085A CPU plus a high-speed buffer and its own PROM-based firmware. A DMA is included. There's much more. You'll have to read the full specs to believe it.

The Am96/1128.

128K bytes of RAM on a board plus parity with its own built-in refresh. The RAM can be dual-ported. Smaller capacities can be achieved by depopulating the board. The Am95/1128 has twice the capacity of its nearest competitor.

These are just a few members of our Supercomponent family. Call or write us for the facts on all of them.

*iSBC and Multibus are trademarks of Intel Corp.

Advanced Micro Devices

901 Thompson Place, Sunnyvale, CA 94086, Telephone: (408) 732-2400

Advanced Micro Devices
Mail Operations, P.O. Box 4
Westbury-on-Trym, Bristol BS9 3DS
United Kingdom

Your Supercomponents sound really super. Send me all the facts.

Personal Name____________________

Personal Title____________________

Company Name____________________

Town (with postcode)____________________

Country____________________

5/10/80/ED

Visit AMD at the National Computer Conference, Booth #615, Disneyland Hotel Convention Center, Lower Level

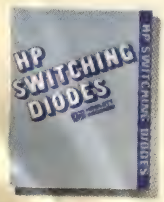
Advanced Micro Devices • France: European Marketing Centre, 27, Boulevard Général-Vautrin, 06400 Cannes, France, Tel: (093) 48.59.75. Silic 314, Immeuble Helsinki, 74, rue d'Arcueil, 94588 Rungis Cedex, France, Tel: (01) 686.91.86. **Belgium:** Avenue de Tervueren, 412, bte 9, 1150 Bruxelles, Belgium, Tel: (02) 771.99.93. **Germany:** Rosenheimer Str. 139, 8 Muenchen 80, West Germany, Tel: (089) 40 19 76. **Italy:** Centro Direzionale, Palazzo Vasari, 3rd Floor, 20090 Milano 2, Italy. Tel: (02) 21.39.020. **United Kingdom:** 16 Grosvenor Place, London SW1X 7HH, England, Tel: (01) 235-6388.

SURPRISE!

Applications Support Package for Digital Designers.

HP Schottky Diodes can solve the problems digital designers encounter with forward voltage, switching speed, temperature stability and reliability. HP Schottky Diodes offer 0.3 V. turn-on voltages, picosecond switching, excellent temperature stability and a machine insertable double-stud package.

For more information or immediate off-the-shelf delivery on these components, call any franchised HP distributor. In the U.S., contact Hall-Mark, Hamilton/Avnet, Pioneer Standard, Schweber, Wilshire or the Wyle Distribution Group (Liberty/Elmar). In Canada, call Hamilton/Avnet or Zentronics, Ltd.



FREE APPLICATIONS SUPPORT PACKAGE

For your free collection of applications notes which contains detailed technical descriptions of HP diodes in digital circuits, circle the reader service card.

HEWLETT
PACKARD

05002

CIRCLE NO. 6

Editorial

Don't stand still—keep up at all costs

Not so long ago, nobody had even heard of a microcomputer. Today, they are everywhere, and getting more powerful day by day. In the flicker of an eyelash, we've moved from 4 to 8 to 16-bit word lengths. And 32 bits is around the corner, followed closely by entire minicomputers—and possibly mainframes—on a few chips.

Have we exceeded our capacity to make practical use of these super chips or even to produce them in quantity when they do become commercially successful? Should we stop and catch up with what we've got?

We say no. We say don't stand still, don't go backwards—keep up.

True progress can be defined only in hindsight. Technological "advances," we can define at least by example—squeezing more functions onto a chip, for instance, while keeping the chip reasonably sized and priced.

No one can say for sure where advances will lead, so technology must ignore red lights. Whole new industries have been created even when there seemed to be little or no demand for a product. Immeasurable human and social benefits have accrued from blind breakthroughs—advances made with no immediate goals in mind or clear ideas of where the advances would lead.

Admittedly, the 32-bit machine may end up a dud. Or it may end up pigeonholed in specialized applications. It's doubtful, but no one knows for sure. Some of us will pay a price to find out. But that's the price of progress.

Innovation will keep us healthy—if we believe

The economic watchdogs say we're right on the brink of a recession, maybe in one now. But we don't see the electronics industry as being anything but generally healthy for some time to come.

Undoubtedly, inflation and the high cost of money are exerting the same pressures on our industry as on others. Profit margins are under attack (witness the earnings decline reported by a major instrument manufacturer for the first time in eight years). Materials are way up, and labor costs are soaring. Yet ours is one of the few industries—perhaps the only one—that has been able to make innovation work to not only hold down—even reduce—prices, but also offer much more for the money.

The plight of one company or even a few does not make a downturn. We think the problem is a temporary wrinkle which will sort itself out as manufacturers learn to cope with an accelerated rate of inflation.

During the last downturn, both instrument and equipment manufacturers found innovation—in the form of leading-edge microprocessors, memories and other dense ICs—very protective. This time around, innovation, coupled with abundant backlogs, should be just the preventive medicine to keep us going strong.

Unless we talk ourselves out of it, and start running scared.

Control Interface
Memory Module
Memory Module
Me
Mo
BXP™

Multiple Choice Memory

Intel's new modular Series 90 system with BXP™ bus lets OEMs build to suit.

Choose your capacity. Choose your memory technology. Choose your speed. Now you can choose from a wide range of performance features that precisely match your product requirements—all with a single memory system.

Intel's Series 90 gives designers a ready-made family of memory modules and intelligent controllers that dramatically simplify and speed-up OEM memory design. Better yet, Series 90 eliminates the cost of designing new memory interface and control circuits for each new system and each new performance or density upgrade.

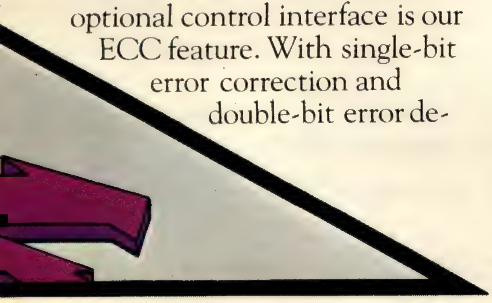
New bus standard for memory systems

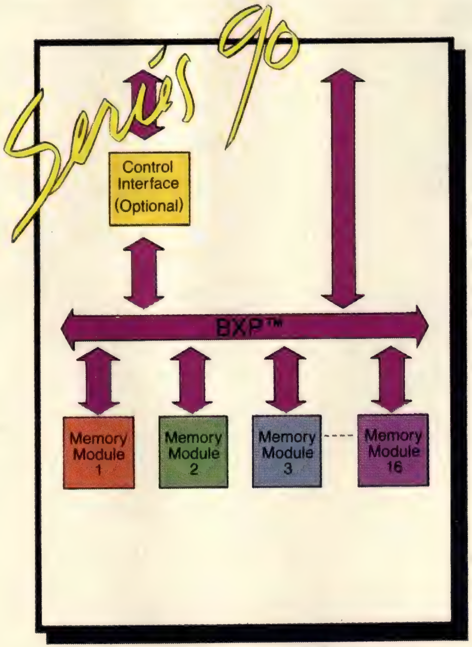
The key to Series 90's design flexibility is our BXP bus. It's the first bus standard made exclusively for memory systems, and it's designed to make interfacing easy. Connect your system directly to the BXP bus or use our standard control interface.

Intel's BXP architecture lets you build to today's needs with flexibility for the future. The BXP bus will accommodate vastly increased capacity, including tomorrow's higher density memory technologies as they arrive.

ECC for unimpeachable data integrity

A primary function of Series 90's optional control interface is our ECC feature. With single-bit error correction and double-bit error detection, it gives your system the highest data integrity available. The controller also supports an optional error logger and display.





Intel's Series 90 lets you design as many as 16 static and/or dynamic memory modules totalling 4 Mbytes on the BXP bus. Connect your system directly to the bus or use our optional control interface.

Performance to spare

Series 90 memory modules incorporate Intel's highest performance semiconductor memory components to give your systems the competitive edge. Our static memory modules use revolutionary HMOS* technology with 100ns cycle times. Or build with Series 90 dynamic memory modules.

Even better, our BXP bus allows you to interleave modules or combine both static and dynamic memory in the same system.

Address up to 2 billion bytes

Series 90 gives you plenty of memory for today's applications—plus wide open capacity for growth. Our BXP bus can accommodate word sizes from 16 to 80 bits plus Error Checking and Correction. It can easily address up to sixteen memory modules for a maximum capacity of 4 megabytes.

Whether you're adding more of today's memory technology or upgrading to higher density components of the future, our BXP bus stays with you.

Non-stop to market

Series 90 is available now, so you can start designing today. For complete information, plus our convenient Configuration Guide, fill out the coupon for a fast response, or contact your local Intel sales representative. Or write Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

*HMOS is an Intel patented process.

intel® delivers.

Europe: Intel International, Brussels, Belgium, Telex 24814.
Far East: Intel Japan K.K., Telex 781-28426.

Mail this coupon now for immediate information on Intel's Series 90 Memory Family . . . plus our convenient Configuration Guide.

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City, State, Zip ______________________

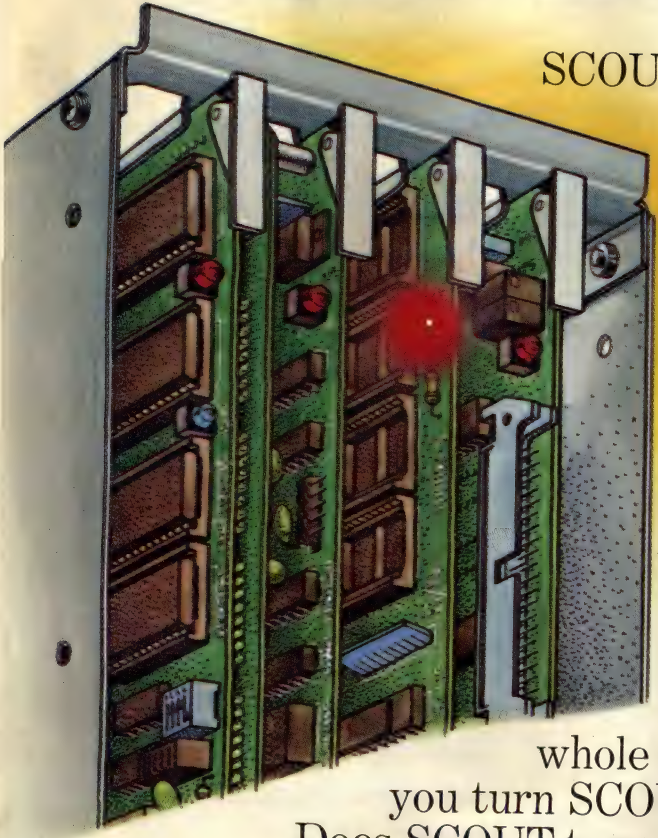
Phone (________) ______________________

Intel Corporation, Literature Department 3065 Bowers Ave.,
Santa Clara, CA 95051 LP-AP ED

See us at NCC at Booth #1354-60

CIRCLE NO. 7

Speak SCOUT, speak.

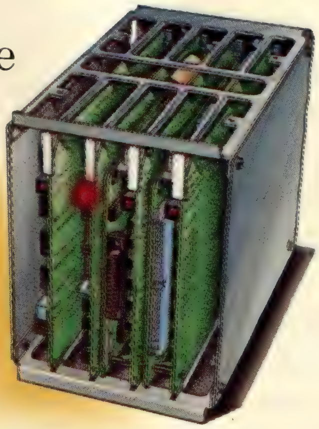


SCOUT™ is a smart minicomputer. He can tell you when one of his boards is bad. Good SCOUT!

How does SCOUT do this? SCOUT has ISOLITE.™ Do you see the red light? It means ISOLITE is testing the board. If the light stays on, the board is bad. Bad boards don't get to play anymore. They get replaced with a spare 6.25″ x 8.3″ card in about three minutes.

Isn't ISOLITE neat? It can even test your whole system every time you turn SCOUT on.

Does SCOUT turn you on?



Think what three-minute maintenance could do for your bottom line. Think what it could do for your product line. Everyone will love your products. You will grow very rich.

You will save up front, too. SCOUT starts at less than $1K for a 16-bit CPU, I/O, 32K Byte RAM and card cage. So, SCOUT also speaks to value.

Speak SCOUT, speak.

See SCOUT run At NCC Booth #3014.

A Plug for SCOUT.

See the light.

Every bit of the 16-bit performance you need, plus incredible operating economy. It's all in our how-to-save-on-maintenance primer, *A Plug for SCOUT.* Get your free copy with this coupon and a business card. Or, for immediate information, call 714/833-8830, Ext. 455.

Name Title

Company

Address

City State Zip

ComputerAutomation

NAKED MINI® Division

Where OEM'S come first.

18651 Von Karman, Irvine, CA 92713

SCOUT and ISOLITE are registered trademarks of Computer Automation, Inc.

CIRCLE NO. 8

Letters

More optocoupler data needed—a lot more

Regarding your article on fast DMOS optocouplers (March 29, 1980, p. 60): I am surprised that you would publish (and feature on the cover) what amounts to a four-page endorsement of puffery and unsubstantiated statements with no footnotes, references or test data to validate claims.

1. For example, the author would like to leave the impression that reed relays are several times more expensive than this technology. A professional approach would have been to prepare a table identifying the devices and the load, and giving range quotations.

2. The author states, "On-resistance for many MOS power devices is less than 0.5 Ω with *no* current leakage in the off-state." This statement appears to be a smoke screen: There is leakage in any semiconductor device; and the 0.5 Ω does *not* apply to the 20-Ω device described in the article.

3. Certainly Theta-J Corp. knows that temperature-cycling and pressure-pot tests have historically been a problem with this construction. I see no reference to any data indicating that any (let alone extensive) environmental testing was successfully accomplished.

4. The 2500-V isolation cited is nothing with this type construction—one should achieve 5000 minimum. It would have been cogent, though if details had been specified. Is the 2500 V a step functon; is it ramped? Does Theta-J propose to do it as a 100% test on every device?

5. The article also states that line transients will not latch MOS devices on as they would, say, a triac. Snubbers have long been used to prevent dv/dt problems. In reality, the problem is not one of latching on. The device will turn off at the next zero-crossing; and in almost any power application, a half-cycle on will not activate a motor, clutch, solenoid or lamp.

6. On the matter of zero-crossing, special circuitry for inductive loads is no longer necessary. Most applications use a microprocessor somewhere; hence, turn-on at optimum time is merely a software routine.

7. Furthermore, the article could have pointed out that bonding to GaAs devices is not the most reliable at this time and that many manufacturers, recognizing that this is a weakness in optodevices, are working diligently to achieve satisfactory reliability goals. Most sophisticated users are aware of this and are working with the industry to overcome this shortcoming. Theta-J doesn't mention this. Are we to assume they don't consider it a problem?

Your magazine certainly presents a needed service, bringing new technologies to the users. However, I believe you owe the readers an article that has been critiqued for completeness and technical competence.

Name withheld on request

Theta-J replies

Technical priorities are like fingerprints: No two are alike. Coupling these factors with the space limitations of a four-page article dictates an approach that is careful not to assume too narrow a sphere of interest for its readers. The letter is correct in implying that, in such a case, the expert reader gets "short-changed" on details.

To answer the specific comments:

1. Such a table would be desirable from my aspect also. The highest-performance, most expensive reed relays (over $10.00) in existence cannot switch 300-V inductive ¼-A loads for anywhere near 1-million operations as can the OFM-1A.

2. Oops! The article is in error in referring to no leakage. It typically is 1nA and is specified at 300 nA max. Regarding 0.5 Ω, we did not mean to mislead. The article refers to a 20-Ω unit but we have also delivered 1.5-Ω versions in the same package to selected customers. We have, in fact, produced 0.5-Ω units exactly as alluded to. They are not at a point, however, where they can be priced to bring about broad market acceptance.

3. The stated thermal concerns are well founded. For that reason, the "light pipe" is both made of and surrounded by a flexible, nonyellowing silicone to enhance wire-bond integrity during thermal stress. The case is injection-molded with a 450-F glass-filled polyester and epoxy molded over the silicone "cushion." Transfer molding is avoided for these very same reasons.

4. The OFM-1A units are ramp-tested to 5000 V on a sample basis using methods per UL.

5. Many of our customers have

(continued on page 18)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.

A few of our customers say Abbott MIL Spec power supplies are 99% perfect.

The others say only 98%. For almost fifteen years we have maintained a customer failure rate of 2% for our "C," "S" and "W" MIL Spec power supplies. That's tried and true proof of reliability... in the field.

Our Model "W" family of 400 Hz to DC power supplies is a standard throughout the world for critical military and aerospace applications. They're available with output voltages from 5 to 100 VDC, current levels from 0.3 to 20 amps.

Our "C" family of 28V DC to DC converters and our "S" family of 28V to 400 Hz inverters come in package sizes as small as 2⅛" x 3½" x 3½", and meet the requirements of eleven separate MIL Specs.

For reliability, call Abbott. For delivery, call Abbott. For additional information, write or call Abbott. *See EEM or GOLD BOOK power supply sections.*

abbott transistor

MILITARY PRODUCTS DIVISION

Eastern Offices, 1224 Anderson Ave., Fort Lee, New Jersey 07024 (201) 224-6900 TELEX 13-5332
Western Offices, 5200 West Jefferson Blvd., Los Angeles, CA 90016 (213) 936-8185 TELEX 69-1398

CIRCLE NO. 9

Meetings

National Computer Conference, May 19-22. Anaheim Convention Center, Anaheim, CA. IEEE, Inc., 345 E. 47 St., New York, NY 10017.

International Microwave Symposium, May 28-30. Shoreham Americana Hotel, Washington, DC. IEEE.

Pulse Power Modulator Symposium, June 3-5. Orlando Marriott Inn, Orlando, FL. IEEE.

International Conference on Communications, June 8-11. Red Lion Inn, Seattle, WA. IEEE.

International Symposium on Electrical Insulation, June 9-11. Howard Johnson, 57 Park Plaza Hotel, Boston, MA. IEEE.

DATACOMM International Mini/Microcomputer, Microprocessor Exposition, June 17-19. Palais des Expositions, Geneva, Switzerland. ISCM, 222 W. Adams St., Chicago, IL 60606.

Power Electronics Specialists Conference (PESC), June 17-19. Dunfey Atlanta Hotel, Atlanta, GA. IEEE.

Chicago Spring Conference on Consumer Electronics, June 18-19. Arlington Park Hilton, Arlington Heights, IL. IEEE.

International Quantum Electronics Conference, June 23-26. Sheraton-Boston Hotel, Boston, MA. IEEE.

Conference on Precision Electro-Magnetic Measurements, June 23-27. Stadthalle, City of Braunschweig, Federal Republic of Germany. IEEE.

Power Systems Monitoring and Control International Conference, June 24-26. London, England. IEEE.

Power Engineering Society Summer Meeting, July 13-18. Radisson Hotel, Minneapolis, MN. IEEE.

Nuclear and Space Radiation Effects Conference, July 15-18. Cornell Univ., Ithaca, NY. IEEE.

Quartz Crystal Conference, Aug. 12-14. Radisson Muehlebach Hotel, Kansas City, MO. K-N Enterprises, Inc., 630 S. Rogers Rd., Olathe, KS 66061.

Intersociety Energy Conversion Conference, Aug. 18-22. Olympic Hotel, Seattle, WA. IEEE.

Engineering in the Ocean Environment, Sept. 8-10. Olympic Hotel, Seattle, WA. IEEE.

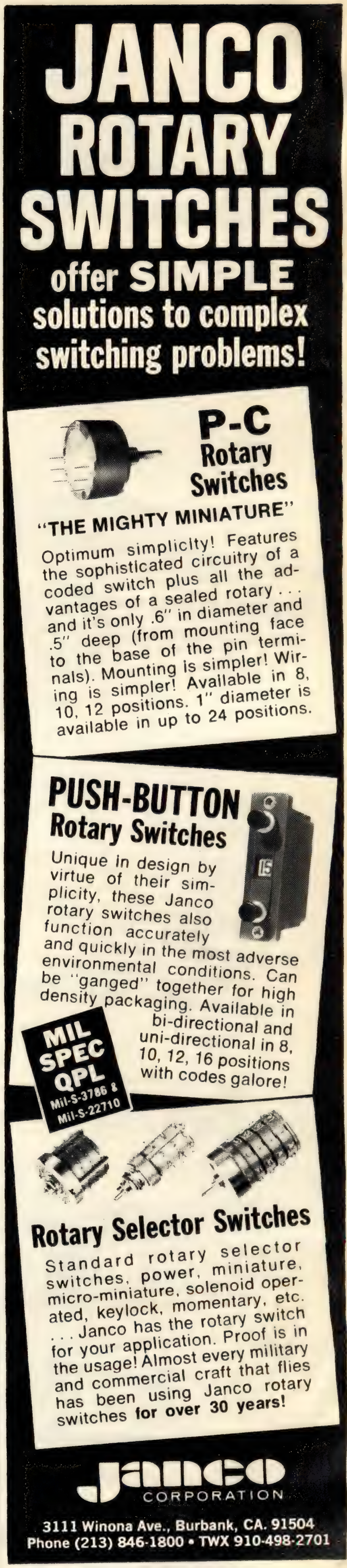
International Congress on Transportation Electronics, Sept. 15-17. Hyatt Regency, Dearborn, MI. IEEE.

European Solid-State Device Research Conference (ESSDERC '80), Sept. 15-18. University of York, York, England. IEEE.

Optical Communication European Conference, Sept. 15-19. University of York, York, England. IEEE.

Electromagnetic Compatibility, Conference, Sept. 15-19. University of Southampton, Southampton, England. IEEE.

International Symposium on Subscriber Loops and Services (ISSLS '80), Sept. 15-19. Bayericheoss, Munich, W. Germany. IEEE.



JANCO ROTARY SWITCHES offer SIMPLE solutions to complex switching problems!

P-C Rotary Switches

"THE MIGHTY MINIATURE"

Optimum simplicity! Features the sophisticated circuitry of a coded switch plus all the advantages of a sealed rotary . . . and it's only .6" in diameter and .5" deep (from mounting face to the base of the pin terminals). Mounting is simpler! Wiring is simpler! Available in 8, 10, 12 positions. 1" diameter is available in up to 24 positions.

PUSH-BUTTON Rotary Switches

Unique in design by virtue of their simplicity, these Janco rotary switches also function accurately and quickly in the most adverse environmental conditions. Can be "ganged" together for high density packaging. Available in bi-directional and uni-directional in 8, 10, 12, 16 positions with codes galore!

MIL SPEC QPL
Mil-S-3786 &
Mil-S-22710

Rotary Selector Switches

Standard rotary selector switches, power, miniature, micro-miniature, solenoid operated, keylock, momentary, etc. . . . Janco has the rotary switch for your application. Proof is in the usage! Almost every military and commercial craft that flies has been using Janco rotary switches **for over 30 years!**

Janco
CORPORATION

3111 Winona Ave., Burbank, CA. 91504
Phone (213) 846-1800 • TWX 910-498-2701

CIRCLE NO. 10

microinterface modules™

WE ARE MIDTEX...
WE ARE RELAYS...AND MORE...

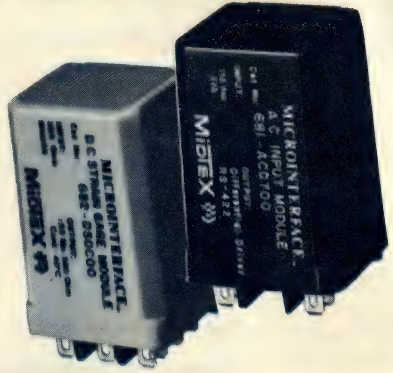
A Proven Industrial Concept...
Microprocessor 1/0's.

The MidTex Microinterface Module...flexible...low cost...versatile...a readily expanded and maintained method of interconnecting the input sensors and output devices to the microprocessor system.

Standard industrial type plug-in enclosures...designed for harsh environments...ideal for industrial and process-control applications. Digital input and output modules...DC and AC for control functions...and analog modules to interface a variety of sensors to the A/D converters associated with microprocessor systems.

When you need a Microinterface Module...
call 507-625-6521
or write MidTex, Inc.
1650 Tower Blvd., North Mankato, MN 56001

THE TOTAL RELAY COMPANY
MIDTEX
INCORPORATED



CIRCLE NO. 11

(continued from page 15)

found snubbers are often undesirable because of cost, board space, or because of the reactive leakage currents that result. To a 400-Hz high-impedance load, a snubber can start to act like a closed switch. I must also emphasize that hundreds of machine-tool applications have high-speed solenoid functions where frequent half-cycle erroneous operation is unacceptable. Furthermore, it has long been known that transients from a phase-controlled thryistor in one location can slave-trigger a thyristor in another. Indeed, the device turns off at the next zero crossing—only to be triggered on again every half-cycle.

6. The comments about zero crossing are on the beam but the writer would be surprised at how many engineers are still scared stiff of microprocessors and prefer to do things the old way.

7. Again, right on. Bonding to LEDs requires constant reliability diligence because of metalization anomalies and the small wires and bonding pads. Besides bonding difficulties, edge creep of conductive bonding epoxies is a concern. You might say we have learned to work with LED chips the hard way. Since over 500-million LEDs and optocouplers were shipped last year, however, we have plenty of company.

In conclusion, let me acknowledge all of the writer's comments as reasonable. His company has long had a disciplined and inquisitive approach to new products. I respect that and regret that it is perhaps not feasible to say all that could or should be said about a new technology in 3000 words or less.

E. T. Rodrigues, President
Theta-J Corp.
208 W. Cummings Park
Woburn, MA 01801

NATIONAL ANTHEM

SEMICONDUCTOR NEWS FROM THE PRACTICAL WIZARDS OF SILICON VALLEY.

Data acquisition rethought.

BLC-8715 INTELLIGENT ANALOG INTERFACE SMOOTHS OUT PROCESS CONTROL.

The ultimate CRT controller

National and Widlar do it again

New IC pressure transducers

Introducing STARPLEX™ with ISE™

Checking out the National Archives

Data Acquisition Logic Transistors Hybrids Linear Interface Bubble Memory
RAMs/ROMs/PROMs Transducers Displays Custom Circuits Optoelectronics
Memory Boards Microprocessors Development Systems Microcomputers Modules

NATIONAL ANTHEM

Major CRT makers demand ultimate controller.

National's DP 8350 Series of single-chip CRT controllers form the heart of over 60 terminal designs worldwide.

Over 50 major CRT terminal manufacturers from around the world have discovered the industry's only complete, single-chip CRT controllers.

National Semiconductor's powerful line of CRT controllers – the DP8350 Series – requires considerably less support circuitry than any other controller on the market.

Due in part to their bipolar (I^2L) circuitry, the DP8350 Series is widely regarded as the ultimate in CRT display refresh circuits.

Single-chip versatility. The 40-pin DP8350 Series – which includes the DP8350, DP8352 and DP8353 controllers – offers a full range of features using internal mask-programmable ROM.

Since the need for a microprocessor interface has been eliminated, overall system design is greatly simplified.

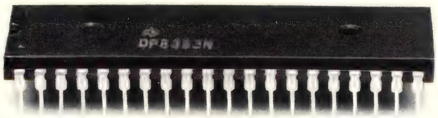
The versatility inherent in the DP8350 Series cannot be understated. In the character field, for example, both the total number of dots per character field and the number of scan lines per character may be specified (up to a 16 x 16 dot matrix). The number of characters per row (from 5 to 110) and character rows per video frame (from 1 to 64) may be specified as well.

A complete set of video outputs is available including cursor enable, programmable vertical blanking and programmable horizontal and vertical sync.

Doing more for less. The popular DP8350 Series does more to lower your system costs than any other single component. And since it requires so little in the way of support circuits, the engineer can spend much more time (and board space) on the more demanding aspects of the product design.

The Practical Wizards at National not only offer superior controllers, they also produce a wide variety of complementary design components. Character generators, microprocessors, memory products, just to name a few.

It's no wonder that the DP8350 is at the heart of the best designs. The industry certainly knows a winner when it sees one.



National's new BLC-8715– a more intelligent approach to data acquisition.

High-speed intelligent I/O board offloads analog pre-processing functions from the data acquisition system CPU.

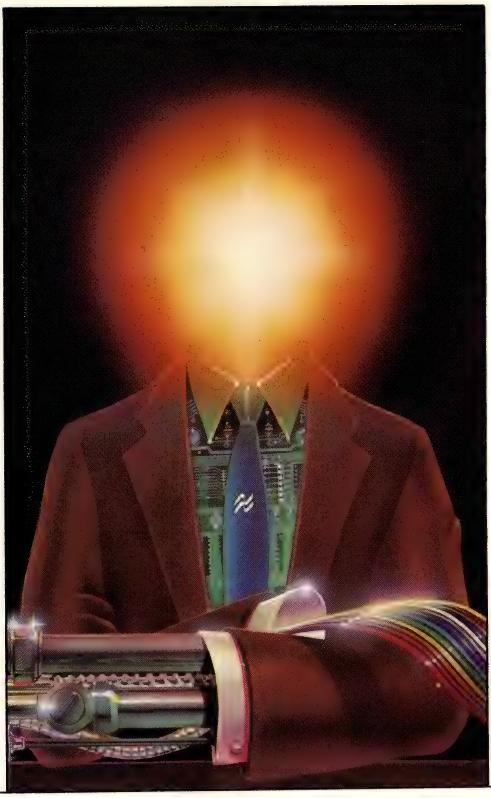
National announces a bright new addition to its family of Series 80 Board Level Computers: the BLC-8715 Intelligent Analog Input Board.

The BLC-8715 was specifically designed for industrial data acquisition and process control systems. This new microprocessor-based interface offloads all of the analog data pre-processing functions normally performed by the host CPU.

And in doing so, the CPU may then devote more of its valuable resources to the rest of the control system.

Faster than a speeding digit. Besides freeing up host system resources for more demanding tasks, there are many reasons why the rugged BLC-8715 smooths out process control.

One of the most dramatic is its A/D conversion speed. Based on National's proven BIFET™ technology, the 8-bit BLC-8715 Analog Input Board performs the A-to-D conversion in a scant 8μsec.



More versatility than ever before. The BLC-8175 performs "front end" measurement and control functions for 16 analog processes. But that's not all.

It also features 22 digital (TTL-compatible) lines for controlling simple on/off equipment functions, digital read-outs, and even keyboard manual override systems.

And to further increase the board's versatility, the Practical Wizards at National designed it so that it may be configured in either of two ways.

By using its standard RS232C interface, the BLC-8715 becomes a remote "slave" to the CPU host.

However, the intelligent I/O board can also interface directly with the host system bus. One of the many benefits of this approach is the BLC-8715's Mailbox memory: 256 bytes of RAM that are directly addressable by any intelligent device on the bus.

It certainly comes as no surprise that National should be the first to take a more intelligent approach to data acquisition and process control.

After all, that's what Practical Wizardry is all about.

BIFET is a trademark of National Semiconductor Corporation.

The LM11. A dramatic advance in op amps.

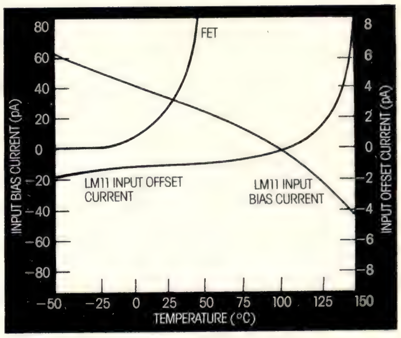
This new op amp represents the largest single advance in bipolar op amp design in over a decade.

National again drives home its leadership in linear with the new LM11 precision DC amplifier.

Designed by Bob Widlar, the LM11 incorporates the best features of existing bipolar designs – and then some:

50pA input bias current (max)
10pA input offset (max)
300μV offset voltage (max)
3μV/°C drift (max)

As shown in the graph, the LM11's input bias current is not only very low, it also remains well behaved over the entire mil-temperature range.



Leakage current only affects input current of the LM11 above +125°C.

An order of magnitude better than FETs. Overall, the new LM11 reduces DC error terms to such an extent that the op amp is no longer the limiting factor in many practical designs. Especially over the mil-temp range.

Further, its offset voltage, drift and long-term stability are an order of magnitude better than FETs.

Although internally compensated with provision for offset balance, the new LM11 is pin-compatible with, and quite similar to, the well-known LM108A amplifier.

STARPLEX™ aids μP system development.

STARPLEX with ISE,™ the fully developed development system.

Using the STARPLEX development system with National's 8048 Emulator Package, designers of 8048 Family systems get the kind of sophisticated tool needed for efficient microcomputer development.

And with 8048 ISE (In-System Emulator), they get capabilities that up to now simply haven't been available in this type of instrument.

What is ISE? National's ISE is a separate STARPLEX module housing 32K bytes of real-time map memory, plus all the necessary logic for breakpoints, tracing, and memory mapping.

ROM display and disassembling. The 8048 emulator package has its own 4K of RAM dedicated to the real-time emulation of the processor's program ROM. So the designer has complete access to this memory throughout emulation.

He may examine and disassemble existing ROM contents, make changes, and execute the altered code. This gives him considerable flexibility in a new product design, as well as in debugging existing systems containing a previously masked 8048.

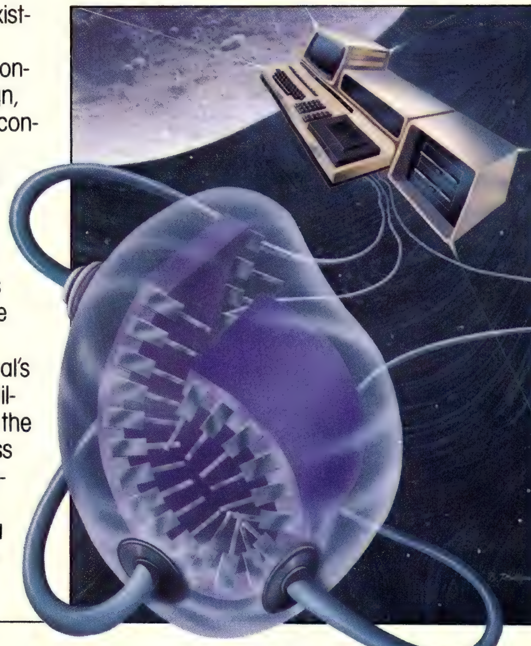
STARPLEX can not only develop and debug software for the 8048 Family, but also for 8080 and Z-80® microprocessors plus BLC/SBC Series 80 boards. NSC800, 8070 and other ISE packages will of course become available as these new processors are introduced.

When you get right down to it, National's STARPLEX with ISE offers features not available in any other development system on the market today. Yet it costs substantially less to own and operate than any system currently being sold.

Practical Wizardry strikes again.

STARPLEX and ISE are trademarks of National Semiconductor Corporation.

Z80 is a registered trademark of Zilog Corporation.



Economical IC pressure transducers from National.

Ever since National introduced the first hybrid IC pressure transducer in 1973, engineers have "robotized" a wide variety of electromechanical applications.

Today National offers the broadest line of IC pressure transducers on the market. Their line encompasses not only hybrids, but a full range of monolithic devices as well. All of which offer pressure systems engineers much greater design flexibility than ever before. At much lower design costs than ever before.

These IC pressure transducers are compact and easily interfaced with other integrated circuits. And because National processes silicon in large volume, they can offer these products at very low costs.

In fact, their LX05XX and LX06XX monolithics are the lowest cost IC pressure sensors available. They offer high accuracy and ±5 to ±100 psi pressure ranges. Their compact T05 and ceramic packages allow easy PC board installation which cuts costs of OEM pressure systems even further.

Of course, the LX16XX hybrid is also available in a ceramic package. This fully signal-conditioned pressure transducer features built-in temperature compensation, high-level output and full voltage regulation.

The LX16XX, in a nylon or diecast zinc housing with NPT fittings and a snap-on connector, becomes an LX18XX. The LX18XX is ideal for plug-in operation with pressure ranges from ±5 to 300 psi.

For high pressure applications – 100 to 5000 psia – National offers the LX14XX hybrid series. Housed in rugged cylindrical brass or stainless steel, the LX14XX is available with flying leads and an optional fluid isolator. This device is perfectly suited for submersion or tough industrial environments.

For additional information, check the coupon for the Pressure Transducer Data Packet – including the handbook, data sheets and application notes. Everything you need to get in on the "robotic" revolution from the Practical Wizards of Silicon Valley.

What's new from the National archives?

006 ☐ Special Functions Data Book ($6.00)
024 ☐ DP8350 Series Data Sheet and Application Notes
034 ☐ LM11 Data Sheet and Application Note
035 ☐ Additional Series/80 Information
036 ☐ Optoelectronics Handbook ($3.00)
037 ☐ Additional STARPLEX and ISE Information
039 ☐ BLC-8715 Data Sheet
040 ☐ Pressure Transducer Handbook ($3.00)
041 ☐ Additional Pressure Transducer Information

For desired information, mail coupon to:
National Semiconductor Corporation
2900 Semiconductor Drive
Mail Stop 16250
Santa Clara, California 95051

In Europe, mail coupon to:
National Semiconductor GmbH
Industriestrasse 10
D-8080 Fürstenfeldbruck
West Germany

Enclose check or money order based upon appropriate currency. Make checks payable to National Semiconductor. Allow 4-6 weeks for delivery.

NAME________________ TITLE________________
COMPANY________________ PHONE________________
ADDRESS________________________________
ED CITY________________ STATE__________ ZIP__________

National Semiconductor
The Practical Wizards of Silicon Valley.

NA11

© Copyright 1980 National Semiconductor Corporation

Printed in U.S.A.

What's TRW up to now?

A new breed.

The GP 1/4 general purpose metal film resistor.

TRW announces a cost-technology breakthrough in general purpose resistors.

You've never seen a general purpose resistor like this one before . . . because it's metal film . . . not carbon. But, it's designed and manufactured to compete in the general purpose ±5% market.

You get metal film load life stability, TCR, VCR, very low current noise, *and* an attractive price . . . 2¢* in quantity in popular 1/4W size.

And you get it from TRW/IRC, the *original* worldwide metal film supplier. With the technology *and* manufacturing process controlled right here in the U.S.

Consider it your domestic alternative, or use it simply because it's a *better* resistor at a very fair price.

For more information, contact TRW/IRC Resistors, an operation of TRW Electronic Components, 401 North Broad Street, Phila., Pa. 19108. Or call (215) 922-8900.

* 10,000 pc. price on lead tape reel, FOB Philadelphia, Penna.

TRW IRC RESISTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

CIRCLE NO. 12

Mostek Z80 refinements:

---

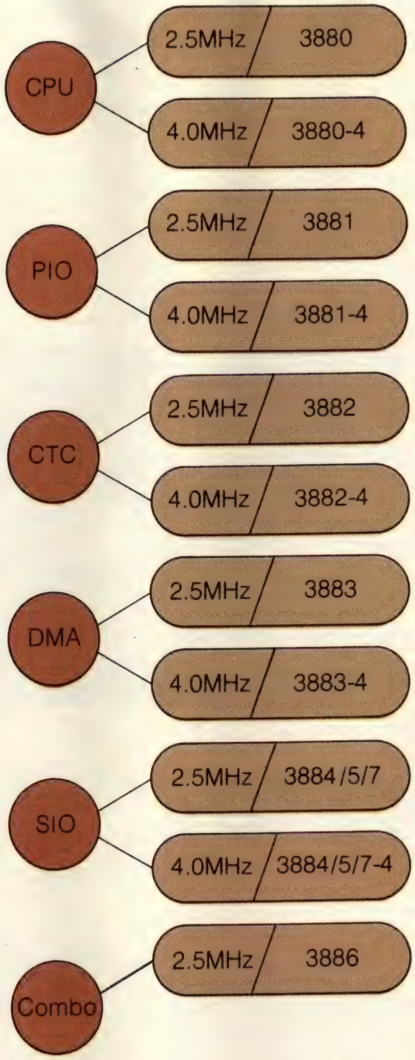
1 4MHz version to make it faster. 2 A Combo Chip to make minimum designs simpler. 3 A complete development system to make programming and debugging easier. 4 And all of it available now from your Mostek distributor.

1 Now you can choose.

The choice? 2.5MHz or 4.0MHz parts from a full product line that includes the SIO and DMA. But other reasons to pick Mostek's Z80 family are equally impressive.

First of all, the Mostek Z80 is recognized and accepted as the industry's foremost 8-bit microprocessor. It's a proven design that's been in volume production for several years.

Then there's the inherent design advantages over the 8085: 158 instructions vs. 80. Fourteen 8-bit CPU registers vs. 7. Ten addressing modes vs. 7. An automatic dynamic RAM refresh. Enhanced 16-bit arithmetic ability. Automatic prioritization of interrupts instead of a separate control device. The list goes on.



2 A practical solution for lower system cost.

Mostek's Combo™ Chip gives you more versatility with fewer parts. It's ideal for minimum chip configuration designs because this single 40-pin circuit contains 256 bytes of RAM with a low power standby mode for 64 bytes. A serial I/O port. Two programmable timers, one of which can be a programmable baud rate generator. Three external interrupts with a programmable vector for each channel. And, of course, a single +5 Volt power supply. So now you can design a complete system with just 3 chips: a Z80 CPU, ROM, RAM, or EPROM memory, and the Combo Chip.

3 A flexible development system.

Mostek's development support includes a variety of choices ranging from single cards to our Matrix™ floppy disk development system with 4.0MHz real time in-circuit emulation. The Matrix system offers a sophisticated resident software package that uses simple commands and comprehensive error messages to save valuable time during program development and debug. Macro Assemblers, BASIC, and FORTRAN are also available for use on the Matrix development system.

4 For all your Z80 needs.

Mostek's complete Z80 family is available now at your local Mostek distributor. So are factory-trained distributor FAEs and demonstration centers at most locations. Contact them for complete information and/or a product demonstration. Military versions are also available. For more information call or write Mostek, 1215 W. Crosby Road, Carrollton, TX 75006, phone 214/323-6000. In Europe, contact Mostek Brussels; phone 660.69.24.

MOSTEK.

© 1980 Mostek Corp.

CIRCLE NO. 13

Catch the fastest C-meter in its price class...the autoranging 830

It's happened again. B&K-PRECISION was the first company to offer a really cost-effective lab-quality C-meter. Now we've done the same for autoranging. The new Model 830 autoranging capacitance meter is fast, accurate and built with famous B&K-PRECISION dependability.

The 830 offers features that are tough to match at any price, such as 0.1 pF resolution, large 3½ digit LCD display and fuse protection against charged capacitors. Basic accuracy is 0.2%, much greater than the tolerance of most capacitors.

Ease of operation is another strong suit for the 830. On the production line, even untrained workers can be quickly instructed on proper operation, making the 830 ideal for component sorting and selection. If capacitors to be measured are limited to a narrow value range, the "range hold" capability of the 830 can freeze it onto one range—an added time saver. This feature, along with the fast reading time of the instrument, makes the 830 especially valuable for incoming inspection applications. On the engineering bench, the 830 is an excellent means of pre-testing critical capacitors.

For applications suited to manual ranging, B&K-PRECISION offers the 820 at an even lower cost. In fact, for the cost of some autoranging units, you could almost purchase both the 820 and 830! The 820 also provides 0.1 pF resolution. With full 4-digit LED display, readings extend to 1 Farad.

With either B&K-PRECISION C-meter, you can measure unmarked capacitors . . . verify capacitor tolerance . . . measure cable capacitance . . . select and match capacitors for critical circuit applications . . . sample components for quality assurance . . . measure complex series-parallel capacitor networks . . . accurately set trimmer capacitors . . . check capacitance in switches and other components. Both instruments have front-panel lead insertion jacks for fast in-out testing.

For details contact B&K-PRECISION or your local distributor:
Austria 0222 56 16 17, Belgium 02-672-8400, Denmark 03-28-38-41, Finland 914-12076, France 54-37-09-80, Germany 02-104-31147, Greece 36.08.443-6, Holland 040-415547, Italy (011)-71.25.97, Norway 034-86-956, Portugal 19-367155, Sweden 08-54-19-80, Switzerland 01-820-57-47, United Kingdom 0602-302331.

Free Demonstration
CIRCLE NO. 165

Additional Information
CIRCLE NO. 292

B+K PRECISION DYNASCAN CORPORATION

International Sales, 6460 W. Cortland Street • Chicago, IL 60635 USA • 312/ 889-1448 • TELEX: 25-3475

LateNews

SLIC mates hybrid, monolithic technologies

The only all-electronic (no transformers) subscriber-line interface circuit (SLIC) has been converted to an MSI-hybrid thick-film combination by developers at ITT North Microsystems division (Deerfield Beach, FL). The previous circuit, the 3801/82, primarily used discrete components on the hybrid substrate. The new circuit uses a bipolar MSI chip that holds most of the active circuitry. The critical-value, laser-trimmed resistors and the high-voltage-handling devices are on the thick-film portion. The result, says ITT, embraces the most reliable aspects of the monolithic and hybrid technolgies. Samples are due in the first quarter of 1981.

Tape-cartridge drive quadruples recording density

A cartridge drive from the Qantex Div. of North Atlantic Industries, Inc., has the heads, electronics and recording codes to boost the recording density in tape cartridges from 1600 bits/in. to 6400 bits/in. As a result, the Hauppage, NY company's Model 400 raises memory capacity on a 600-ft tape from 5.4 Mbytes to 22 Mbytes.

Drive speed is either 30 in./s, where data are transferred at 24 kbytes/s, or 90 in./s. The drive also uses a digital speed-control tachometer and a spring-loaded idler.

Bubble-memory family is complete with controller

A bubble-memory controller chip, the 7220, rounds out Intel's (Santa Clara, CA) line of required support chips for its 7110 1-Mbit bubble memory module. This chip, along with five previously announced support components and eight bubble-memory modules, allows a complete 1-Mbyte bubble-memory system to be constructed on a PC board. First samples of the chip are headed to a major telecommunications-systems manufacturer; volume shipments are scheduled to midsummer of this year.

Multibus-compatible RAM board gets 7-day backup from battery

A 16-kbyte CMOS RAM board that is Multibus-compatible will operate with both 8 and 16-bit systems and has a seven-day battery backup. The $1775 BP-0200 board from NEC Microcomputers, Inc. (Wellesley, MA), features memory deselect in 2-kbyte blocks and memory inhibit for paging two or more boards to the same address block.

CMOS multiplying DAC will provide 0.05% resolution

A precision analog signal attenuator is the primary application for a CMOS multiplying DAC that will be announced by Analog Devices (Norwood, MA). The AD7525 provides resolution better than 0.05% and a gain error of les than ±0.05% of full-scale output (1.999), with a BCD-coded 3-1/2-digit input. Used in the multiplying mode, the device acts as an analog-signal processor, handling swings as great as ± 25-V and providing precise attenuations, according to the BCD instructions, from either display data or coded thumbwheel switches.

Two new computers, four new boards dress up Naked Mini series

Computer Automation (Irvine, CA) will unveil several new products at the upcoming National Computer Conference in Anaheim, CA. The Model 4/95 is a high-performance OEM Naked-Mini series minicomputer, 30% faster than previous models. Its memory-management

LateNews

capability can expand to 8 Mbytes; ECC circuitry corrects all single-bit errors, while a "smart" refresh corrects the entire memory every two seconds.

A systems packaged version, the Naked Mini 4/97, offers the same hardware features as the 4/95, but is designed as the engine that drives the company's new PROTOS software system. PROTOS is a multiuser, virtual-memory operating system combined with support for structured programming. Initial PROTOS software will be ALAMO (a proprietary implementation language), Fortran IV and an assembler.

The company is also adding four support boards for its Scout Naked Mini 4/04, the low end of the family. New boards will provide Scout-based systems with floppy-disk mass storage, 12-bit d/a conversion, digital parallel I/O and battery backup.

Plastic-cased power transistors cut power-supply costs

Three series of bipolar, npn power transistors with high breakdown voltages for switching power supplies and offline converters are slated for second-quarter production at RCA Solid State Div. (Somerville, NJ). The TA9141 series, whose RCA6671 through 73 members will be plastic-cased companions to the TO-3-cased 2N6673 SwitchMax transistor, has 300 to 400-V collector-to-emitter breakdown voltages and is housed in Versawatt, RCA's version of the TO220AB plastic package. Gain-bandwidth product is 2 MHz, and 5-A H_{FE} ranges from 10 to 40, minimum.

Another TA220AB-cased series, the TA8863, offers four devices with collector-to-emitter breakdowns from 250 to 400 V, and a 1-A H_{FE} of at least 10. In addition, the TA9153 series, whose 2N6751 through 54 devices are packaged in JEDEC TO204MA cases (the old metal TO-3 package), offers a 5-A H_{FE} of 10, minimum, with V_{CEV} ranging from 600 to 1000 V.

In 1000-piece quantities, the TA9141s will cost $1.50 to $2.50; the TA8863s, $0.60 to $0.90; and the TA9153s, $4.00 to $6.00.

Portable X-ray scope makes on-the-spot component inspection safer

A hand-held X-ray unit invented by the National Aeronautics and Space Administration significantly reduces the radiation levels needed for real-time imaging. Called the Lixiscope (for Low-intensity X-ray imaging), the device is portable enough to allow unlimited on-the-spot nondestructive inspection of electronic components. A radioactive isotope provides gamma rays equivalent to 20-keV X-rays, while two "D" cells supply power. Total weight is less than 500 grams.

Six companies have been licensed by NASA to manufacture the Lixiscope, but Lixi, Inc. (Downers Grove, IL) is the only company manufacturing commercial units (which cost $7500).

Late Briefs

Industrial process controls from Airpax (Ft. Lauderdale, FL) build upon an Intel (Santa Clara, CA) MCS-48 8-bit μP with 8 kbytes of EPROM and up to 2 kbytes of RAM. **The Series 79 Processor/Monitor will accommodate four analog inputs in the range of 4 to 20 mA at 25 V ac, as well as four TTL inputs** from magnetic tachometer pickups, Hall-effect sensors, pulsed relay circuits, etc. . .**The IEEE standard for the S-100 bus should be formally adopted during May,** according to Task-696.1/D2 Chairman George Morrow (Thinker Toys, Richmond, CA). It will deviate little from the draft that was published in the IEEE's *Computer* magazine (July 1979, p. 28)...**A $199 frequency standard covering 0.1Hz to 5 MHz** is not only designed for calibrating counters, oscilloscopes and other instruments but is also useful as a precision clock source. Global Specialities' (New Haven, CT) Model 4401, provides a crystal-oven oscillator with 0.5 part-per-million stability over 0 to 55 C.

Brite moments in American history.

September 14, 1716. Boston Light shines as America's first lighthouse. *Originally illuminated by oil lamps, the beacon commanded a majestic view of Boston Harbor. During the Revolutionary War, British and American forces vied for control of the lighthouse. When the British evacuated Boston in 1776, rather than yield the lighthouse to the Americans, they blew up the tower, reducing it to rubble. It was reconstructed on the same site, and, more than 200 years later, Boston Light still shines bright.*

Photograph Courtesy of the National Archives

Brite-Lites® Stay Bright.

Our Brite-Lite LED lamps not only shine as bright as incandescents, they shine longer—more than 10 times longer. At 20 milliamps, they'll shine at least 10 years. Continuous or pulsed, they operate without life loss, using less than half the power of an incandescent. And they're 25 times brighter than other LED's on the market. That's dependability in the tradition of Boston Light.

Whether installed in sophisticated computer control panels or simple telephone pushbuttons, our Brite-Lites suit your requirements. Midget-flanged, snap-ins, PC lites, and wide-angle LEDY bugs,® are available in transparent or translucent red, amber, or green; from 1.6 to 48 volts; from 10 to 30 milliamps. And our LED lamps are American-made, so you're assured of dependable, prompt delivery.

When Digital Equipment Corporation conducted a series of tests for plug-compatible LED's which had both the brightness and long life they required, they chose Brite-Lite LED's with solid state reliability to replace their incandescent lamps.

For LED lamps that stay bright, isn't it time you switched to Brite-Lites.

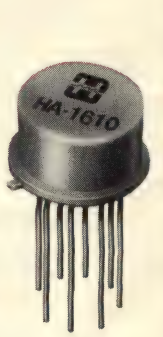
Proven better and brighter than the rest

DATA
DISPLAY
PRODUCTS

Data Display Products
303 N. Oak St., Inglewood, CA 90302
(213) 674-5940 • TWX 910-328-7208

"I can't afford less than the best components
in my data acquisition systems."

Now! Harris introduces Precision Voltage References as good as your systems!



Now, Harris Semiconductor gives you a new family of monolithic voltage references that meet the precision and accuracy requirements of today's high resolution data systems—over temperature, over time, over load.

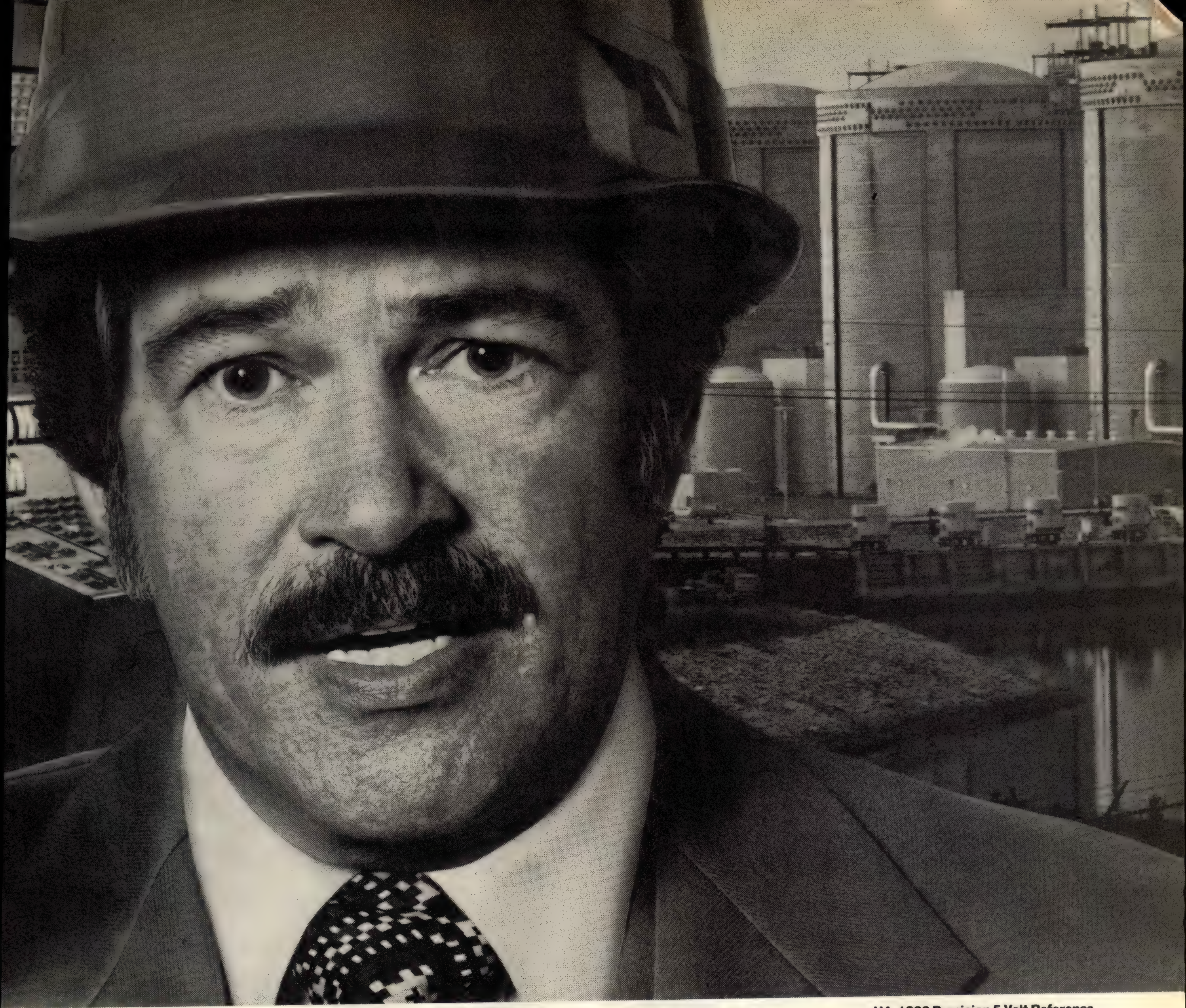
The Harris HA-1600, HA-1610, HA-1615 and HA-1620 are laser-trimmed for precise output voltages within a few millivolts of nominal value. All devices feature outputs buffered by an op amp with an uncommitted feedback loop for current drive flexibility and stability under load.

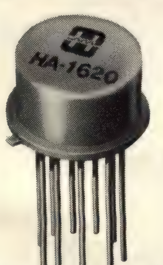
The HA-1600, HA-1610 and HA-1615 are +10 V output devices. The HA-1620 is a +5 V reference with the additional feature that the output can be adjusted ±0.5 V.

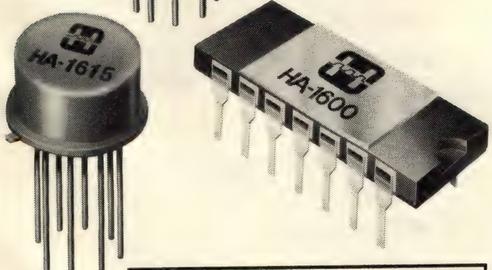
Accuracies of this line of references go to ±1 LSB over full military temperature range for 12-bit systems. **Here's the important bottom line—now you can get a reference that is as good as your system, with accuracies to better than 1 LSB!**

Put a new level of accuracy into your data acquisition system. Specify Harris voltage references. Prices range from $5.00 for the commercial version of the HA-1615, to $30.00 for the military version of the HA-1600 (100-999 quantities). Availability from stock.

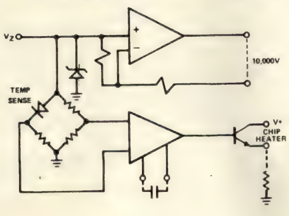
Call the Harris Hot Line, or write: **Harris Semiconductor Products Division, Box 883, Melbourne, Florida 32901.**



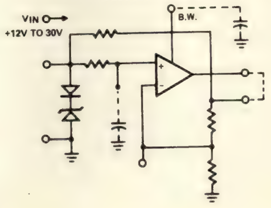




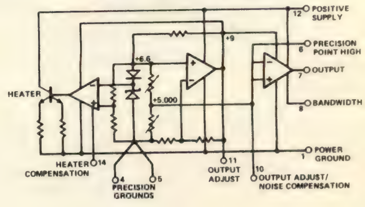
HA-1600 Precision 10 Volt Reference Temperature Regulated Chip



HA-1610/HA-1615 10 Volt Precision Reference



HA-1620 Precision 5 Volt Reference With Adjustable Output



Harris Precision Voltage References Performance Parameters

Harris Part No.	Output Voltage	Temperature Range	Package	Tempco, Max. (ppm/°C)	Line Reg., Max. (%/V)	Load Reg., Max. (%/mA)	Resolution for 1 LSB Accuracy
HA1-1600-2	+10	−55 to +125°C	14-Pin Hermetic Dip	1.35	0.002	0.002	12 Bits
HA1-1602-2	+10	−55 to +125°C	14-Pin Hermetic Dip	2.70	0.002	0.002	11 Bits
HA1-1605-5	+10	0 to +75°C	14-Pin Hermetic Dip	3.25	0.002	0.004	12 Bits
HA2-1610-2	+10	−55 to +125°C	TO-99 Metal Can	3.0	0.004	0.004	10 Bits
HA2-1610-5	+10	0 to +75°C	TO-99 Metal Can	3.0	0.004	0.004	12 Bits
HA2-1615-2	+10	−55 to +125°C	TO-99 Metal Can	5.0	0.004	0.004	9 Bits
HA2-1615-5	+10	0 to +75°C	TO-99 Metal Can	5.0	0.004	0.004	11 Bits
HA2-1620-2	+5	−55 to +125°C	TO-100 Metal Can	1.0	0.002	0.002	12 Bits
HA2-1620-5	+5	0 to +75°C	TO-100 Metal Can	1.0	0.002	0.002	13 Bits

HARRIS HOT LINE!
1-800-528-6050, Ext. 455
In Arizona: 1-800-352-0458, Ext. 455

Call toll-free (except Hawaii & Alaska) for phone number of your nearby Harris sales office, authorized distributor or expedited literature service. Or check your IC MASTER for complete product listing and specifications.

Harris Technology ...Your Competitive Edge

HARRIS
SEMICONDUCTOR PRODUCTS DIVISION
A DIVISION OF HARRIS CORPORATION

CIRCLE NO. 16

THE BEST ADC80 YOU

WE CAN FILL ALL YOUR ADC80 ORDERS IMMEDIATELY FROM STOCK.

Coming up with a vastly improved ADC80 is one thing; making sure that it's readily available in quantity is quite another. Analog Devices has done both.

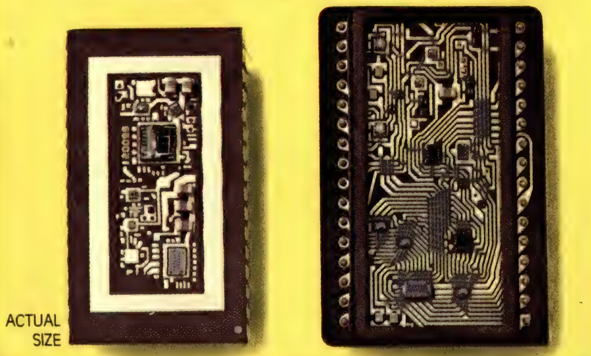
Our ADC80 is a complete 12 bit successive approximation analog-to-digital converter that includes an internal clock, reference and comparator. It needs no external components to perform a 12 bit accurate A/D conversion in only 25 μs. To make it the best ADC80 you can get, we added lots of improvements. First, we only used half as many chips, so it's much more reliable. Then, we used a monolithic D/A chip so we can guarantee no missed codes over a wider temperature range. Ours also consumes less power, and the reference output can supply up to 1.5 mA of current to external circuitry. We even have a 40ns status delay that guarantees valid data at the end of a conversion. After we made a better ADC80, we made darn sure we put plenty into stock. So you can get as many as you need.
Now.

DESIGNED AND BUILT TO LAST FAR LONGER.

Our ADC80 is not only better, it's more reliable. Not only does it have half as many chips (17 versus 34), but we've reduced the number of bond wires by 63% from 177 to 73. We've even improved the packaging with a "SLAM" ceramic dual-in-line package that eliminates the substrate. The result in terms of calculated MTBF is that ours will far outlast theirs.

CAN GET, YOU CAN GET.

AD vs. BB



	AD	BB
Number of Chips	17	34
MTBF (failures/million hrs.)*	15.1	24.8
Temperature Range for No Missing Codes	-25°c to +85°c	0° to +70 C
Power Dissipation	800mW	950mW
Max. Reference Output Current	1.5mA	0.2mA

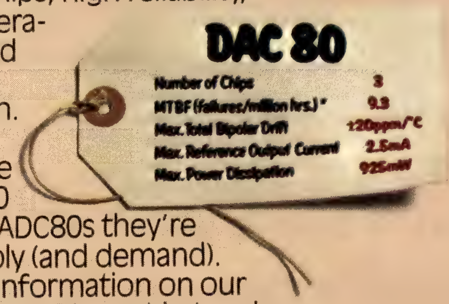
Chip count determined from actual devices. *MTBF's calculated per MIL-HNBK-217C. Other BB data taken from published data sheet.

PERFORMANCE SPECS THAT ARE SPECTACULAR.

Our ADC80 clearly beats the competition (see chart) in terms of chip count, calculated MTBF, temperature performance, power consumption and reference output current. And our 40ns status delay allows you to latch output data directly into a data register without losing the 12th bit. This is a real cost saver, because it means you don't have to add external status delay circuitry.

IF YOU LIKE OUR ADC80s, YOU'LL LOVE OUR DAC80s.

If you're looking for a pin-for-pin replacement for the industry standard DAC80 12 bit D/A converter, look no further. Our DAC80 features an internal output amplifier that settles to ±0.01% in 3 μs (voltage models), guaranteed monotonicity over the 0 to +70°C temperature range, and a low profile ceramic dual in-line package. The same innovative design techniques used in our ADC80s are also incorporated in our DAC80s. So we also have the best DAC80, with fewer chips, high reliability, better temperature drift, and lower power consumption. You'll even love the price of our DAC80 And like our ADC80s they're in great supply (and demand).



DAC 80	
Number of Chips	3
MTBF (failures/million hrs.)*	9.3
Max. Total Bipolar Drift	±20ppm/°C
Max. Reference Output Current	2.5mA
Max. Power Dissipation	925mW

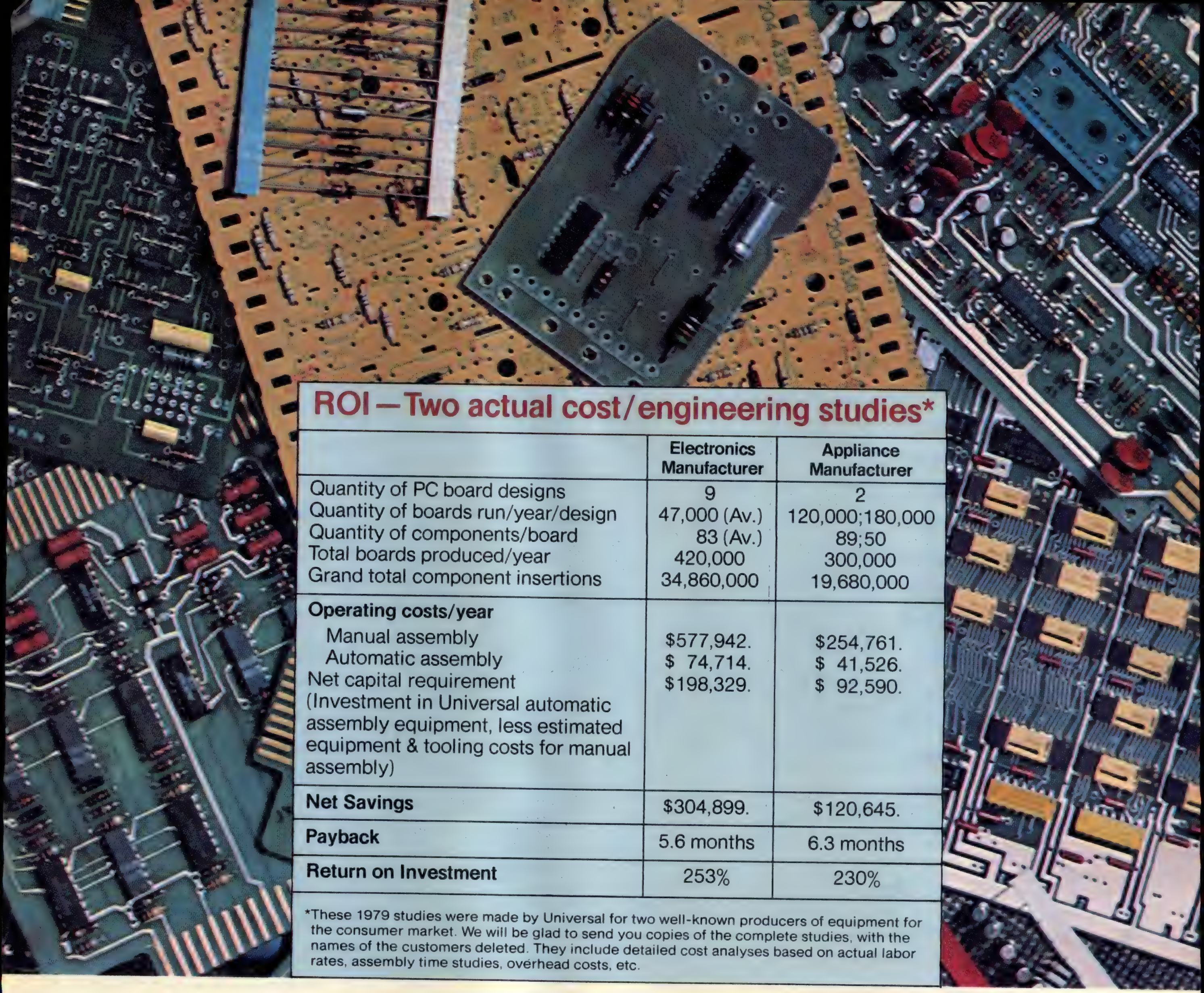
For more information on our ADC80s and DAC80s, get in touch with Doug Grant or Don Travers at (617) 935-5565, or write Analog Devices, Inc., P.O. Box 280, Norwood, MA 02062.

ANALOG DEVICES

WAY OUT IN FRONT.

Analog Devices, Inc., Box 280, Norwood, MA 02062; East Coast: (617) 329-4700; Midwest: (312) 894-3300; West Coast: (714) 842-1717; Texas: (214) 231-5094; Belgium: 031/37 48 03; Denmark: (02) 84 58 00; England: 01/94 10 46 6; France: 687-3411; Germany: 089/53 03 19; Japan: 03/26 36 82 6; Netherlands: 076/879 251; Switzerland: 022/315760; and representatives around the world.

CIRCLE NO. 234



ROI—Two actual cost/engineering studies*

	Electronics Manufacturer	Appliance Manufacturer
Quantity of PC board designs	9	2
Quantity of boards run/year/design	47,000 (Av.)	120,000;180,000
Quantity of components/board	83 (Av.)	89;50
Total boards produced/year	420,000	300,000
Grand total component insertions	34,860,000	19,680,000
Operating costs/year		
Manual assembly	$577,942.	$254,761.
Automatic assembly	$ 74,714.	$ 41,526.
Net capital requirement (Investment in Universal automatic assembly equipment, less estimated equipment & tooling costs for manual assembly)	$198,329.	$ 92,590.
Net Savings	$304,899.	$120,645.
Payback	5.6 months	6.3 months
Return on Investment	253%	230%

*These 1979 studies were made by Universal for two well-known producers of equipment for the consumer market. We will be glad to send you copies of the complete studies, with the names of the customers deleted. They include detailed cost analyses based on actual labor rates, assembly time studies, overhead costs, etc.

Where else can you get this kind of return on your investment?

Universal machines and systems have succeeded in putting circuit board assembly on a mass production basis. An amazing ROI record explains their rapidly expanding use.

Nearly 90% of all printed circuit boards can be automatically assembled at high speed with systems that Universal has developed. And rapid pay-back can be obtained on short runs with a high mix of products as well as on long high volume applications. Our customer files include dozens of cost analyses like the two briefly summarized here. Send us your production requirements and costs. We'll be glad to work up a complete analysis to show you how much "going automatic" can save your company.

Universal Instruments' line includes

- Axial lead component insertion machines.
- Axial lead component sequencing machines.
- Radial lead component sequencing/inserting machines.
- DIP and DIP socket inserting machines.
- Pin insertion machines.
- Pass-Thru™ automatic board handling systems.
- Semi-automatic wire termination machines.
- Computer-based *Satellite Controller*® system for single machines or entire assembly systems.

Universal®

Subsidiary of **DOVER CORPORATION**

Universal Instruments Corporation ▪ Box 825, Binghamton, New York 13902 ▪ Tel: 607/772/7522 ▪ TWX: 510/252/1990

CIRCLE NO. 18

A coprocessor takes over floating point calculations and disposes of them in a fraction of the time needed by a μP relying on software algorithms.

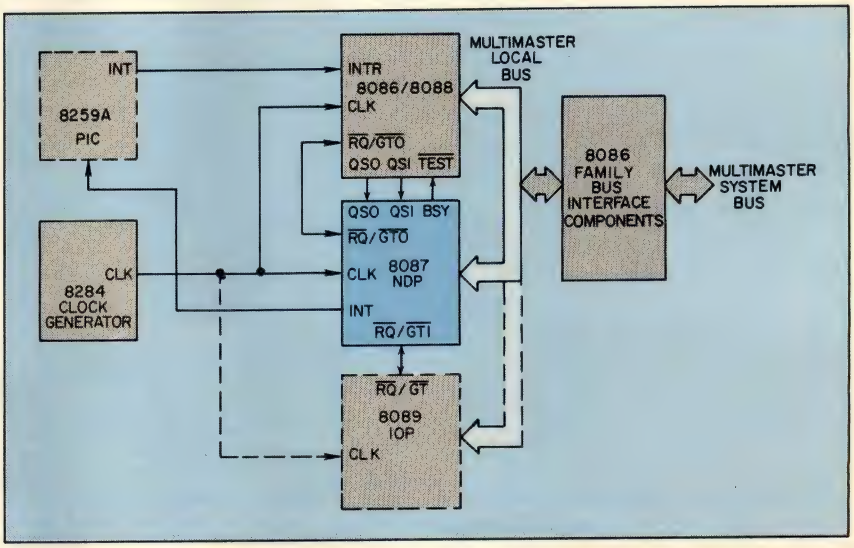
Coprocessor implements floating-point math

Increasingly, high-performance microcomputer systems rely on intelligent support chips to perform special functions. One of the latest of these chips is the Intel 8087 numeric data processor (NDP), which performs floating-point calculations one hundred times faster than a μP using software algorithms.

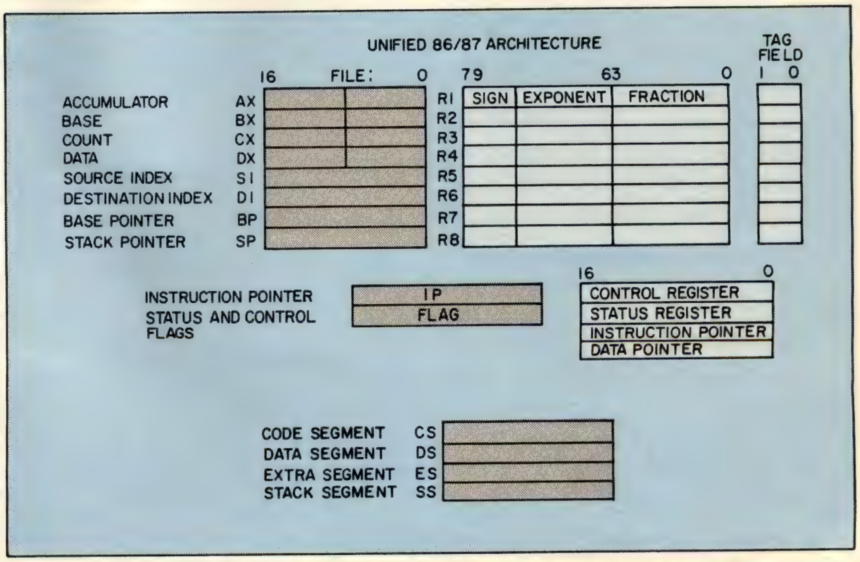
Previous support chips acted as peripherals to the CPU rather than as coexisting processors directly connected to the local bus. The 8087 serves as a coprocessor, monitoring the CPU's instruction stream and taking over when it recognizes certain specialized instructions.

First mentioned at the 1980 International Solid-State Circuits Conference, the device is fabricated with Intel's HMOS-1 process, and mates directly to an 8086 or 8088 microprocessor on a local bus.

The 8087 NDP implements the IEEE floating-point arithmetic format proposed by J.T. Coonan of the University of California at Berkeley. It handles single and double-precision formats, double-extended format, rounding control, precision control, infinity control and required instructions. The instruction set contains data transfer, arithmetic, logic, transcendental, constant and processor control operations (Table 1).



The 8087 monitors the instruction stream on the 8086/8088 local bus and is activated by an Escape instruction.



The 8086 and 8087, working together, appear as a single machine to the programmer. The 8087 adds seven data types to the combination.

An Escape instruction in a sequence of 8086/88 operations activates the NDP coprocessor and makes the 8086/88 perform a read to memory. The CPU ignores the data that come back. Meanwhile, a 6-bit operation code in the Escape command tells the coprocessor what operation to perform. The coprocessor accepts the data coming back and uses it either as data or as a pointer to the start of the data. The coprocessor has temporary control of the data and address buses for retrieving and storing data and results.

The NDP uses the 8086's queue status lines, to obtain and decode its instructions in synchronization with the CPU. The NDP's Busy signal informs the CPU that the coprocessor is executing an instruction, and the CPU Wait instruction tests this signal to ensure that the NDP is ready to execute subsequent instructions. One of the CPU's two Bus Request/Grant lines lets the coprocessor obtain control of the local bus for data transfers. The other line is available for general system use—for instance, an 8089 intelligent peripheral controller operating in its local mode.

Housed in a 40-pin DIP like the 8086/88, the 8087 has an almost identical pinout—only two pins differ. On the 8086, the Wait and Test pins are inputs; on the 8087, the equivalent pin positions are outputs that feed back into the 8086. Since the 8087 uses the same system lock and other hardware, no components have to be added to expand the system, as the block diagram on p. 35 shows.

The combined 8086/88 and 8087 appear to the programmer as a single machine. The 8087 adds seven data types, to the system plus registers and instructions (Table 2).

The NDP's register stack handles computations in eight 80-bit registers. The generous register space holds many constants and intermediate results during calculations, to reduce memory access and improve system throughput. The register stack can be accessed either as a stack (with instructions operating on the top one or two stack elements) or as a fixed register set, (with instructions operating on explicitly designated registers).

The NDP can be substituted in a preprogrammed system with little fuss. To develop programs with advanced math operations

Table 1. Principal 8087 instructions

Class	Instructions
Data transfer	Load and store (for all data types) exchange, free
Arithmetic	Add, subtract, multiply, divide, subtract reversed, divide reversed, square root, scale, increment, decrement, remainder, integer part, change sign, absolute value
Logical	Compare, examine, test, extract
Transcendental*	Tangent, arctangent, 2^x-1, $y \cdot \log_2 x, y \cdot (\log_2 x+1)$
Constants*	0, 1, π $\log_{10} 2$, $\log_\theta 2$, $\log_2 10$, $\log_2 \theta$
Processor control	Load control word, store control word, load status word, store status word, load environment, store environment, save, restore, set interrupt-enable, clear interrupt-enable, clear errors, initialize

*Combining these instructions in very simple routines provides all the common trigonometric, inverse trigonometric, hyperbolic, inverse hyperbolic, logarithmic and power functions.

Table 2. 8087 data types

Data type	Bits	Significant decimal digits	Approximate decimal range
Word integer	16	5	$-32{,}768 \leq X \leq +32{,}767$
Short integer	32	10	$-2.15 \times 10^9 \leq X \leq +2.15 \times 10^9$
Long integer	64	19	$-9.22 \times 10^{18} \leq X \leq +9.22 \times 10^{18}$
Packed decimal	80	18	$-99\ldots99 \leq X \leq +99\ldots99$ (18 digits)
Short real	32	7	$8.43 \times 10^{-37} \leq \lvert X \rvert \leq 3.37 \times 10^{38}$
Long real	64	16	$4.19 \times 10^{-307} \leq \lvert X \rvert \leq 1.67 \times 10^{308}$
Temporary real	80	19	$3.4 \times 10^{-4932} \leq \lvert X \rvert \leq 1.2 \times 10^{4932}$

Table 3. Execution time comparison

Instruction	Approximate execution time (μs)	
	8087 (5-MHz clock)	8086 emulation
Add/subtract magnitude	14/18	1600
Multiply (single precision)	18	1600
Multiply (double precision)	27	2100
Divide	39	3200
Compare	10	1300
Load (single precision)	9	1700
Store (single precision)	17	1200
Square root	36	19600
Tangent	110	13000
Exponentiation	130	17100

before the 8087 becomes available, programmers can use the company's floating-point arithmetic library (FPAL) for 8-bit processors. For the 8086, Intel provides the ASM-86 and PL/M-86, an assembler program and a psuedo high-level language. ASM-86 has directives for defining all 8087 data types and mnemonics for all instructions. The PL/M-86 aids program development, so the programmer does not need a detailed understanding of the CPU architecture.

In their final form, these programs employ Call instructions to access a subroutine that emulates the 8087 instruction. When the 8087 becomes available, the Call instruction is replaced by an Escape command and a Wait instruction, without any other change in the software. This eliminates all subroutines that emulate the 8087 operations and decreases execution time by up to 100 times (Table 3).

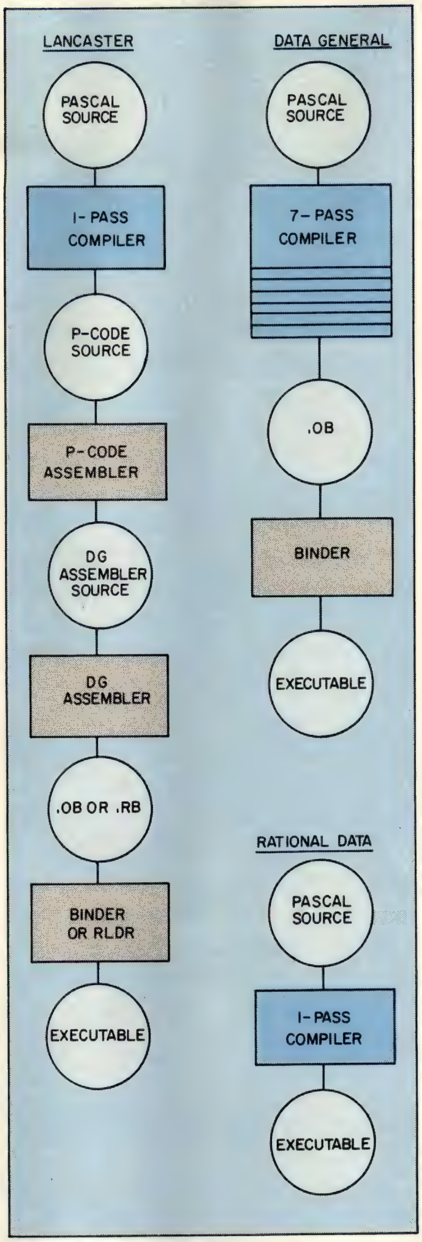
Dave Bursky

'Lazy input' refines interactive Pascal

One obstruction to the interactive use of Pascal—namely one-character look-ahead—is cleared away by a new implementation from Rational Data Systems (New York, NY). Input data stay in the input file buffer until the program actually asks for the buffer variable. An internal Boolean variable, Valid Window, is set false until the input line is complete. This lazy input does not violate the Pascal standard and is transparent to the user.

Since the RDS implementation needs no language modification, interactive Pascal programs remain as easy to read as any other Pascal code. Nor does the RDS solution depend on the operating system.

As a side effect, lazy input improves the efficiency of execution because lines are read as a whole. RDS Release 1.0, which contains the feature, also permits the user to define his own end-of-line character. The release runs on all Data General CPUs, under operating systems AOS, RDOS and DOS.



Rational Data's Pascal compiler is more direct than Data General's, but both are much simpler than the very popular Lancaster implementation.

RDS contends that its Release 1.0 conforms closer to the Pascal standard than Data General's MP/OS, which has only recently implemented nested procedures. On the other hand, MP/OS permits separate compilation, which RDS will implement later. Another major difference between the two implementations lies in the way that language is executed (see figure).

Data General's MP/OS creates threaded code in a seven-pass compiler, which has to pass through the Binder utility. Rational Data's single-pass compiler generates byte-oriented p-code which contains the needed library routines, so no binding is necessary. The latest release, 1.04, available April 28, processes about 900 lines/min.—similar to Data Generals's MP/OS.

Max Schindler

Processing discovery helps GaAs devices

Both the cause and the cure for performance and reliability problems in gallium-arsenide devices emerge from a new processing discovery by the Office of Naval Research (Arlington, VA). The probable cause: Dopant impurities tend to move about within the GaAs lattice. The cure: Dope the GaAs with impurities that cluster into aggregates too large to migrate in the lattice.

Max Yoder, Electronic and Solid-State Program Manager at ONR, presented this solution to the Semi-insulating III-V Material Conference in Nottingham, England, last month. He also announced that one manufacturer has already applied ONR research to build devices with the abrupt impurity gradients necessary for high gains at X-band frequencies.

Cooperating with ONR, Varian (Palo Alto, CA) has coupled low-noise with high associated gain in an X-band GaAs FET. Using a 0.2 × 50-μm gate, the Varian transistor mates a 1.19-dB noise figure with 14 dB of associated gain at 8 GHz.

In conventional GaAs FETs, mechanical stress contributes heavily to the migration of impurities at the GaAs surface. When a die has induced strain fields, the impurities can travel well into the bulk material. The mechanical instability of dopants seems to be responsible for the low reliability of many GaAs devices. Moreover, biasing such a FET for low noise results in associated gains of about 5 dB at X-band frequencies.

Yoder ranks stress first in the order of factors that affect impurity distributions and diffusivities. The concentration and location of every impurity in the device must be considered to analyze the contribution of any single impurity.

Donor atoms, such as silicon, are typical of the impurities that remain mobile after the crystal is annealed. But adding sulfur or selenium solves the problem of silicon mobility, by creating complexes that are too large to move within the GaAs lattice. Both the Si-S and Si-Se complexes act as donors: The silicon occupies a gallium site in the lattice and the sulfur or selenium occupies an arsenide site.

Yoder feels that the formation of complexes explains why boron implants make GaAs semi-insulating (see box). The theory is backed up by proof that boron dopants remain perfectly fixed in the GaAs lattice structure. Rather than migrate, a boron atom forms an arsenic vacancy next to it in the lattice and combines into a complex with the vacancy. The arsenic vacancy then becomes a ready trap for any donor impurity that is subsequently injected. This boron principle applies equally well to any GaAs structure, whether it is grown by liquid or by vapor-phase epitaxy.

The semi-insulating property is an essential ingredient for planar technology in GaAs. Planar devices, in turn, are the precursors of ICs. GaAs substrates that are reliable and stable semi-insulators lead to devices that can be located anywhere in a wafer, so long as boron is implanted at the proper locations in the crystal lattice.

The theory of complexes helps to explain some other puzzling results in the literature, according to Yoder: apparently greater than 100% activation of low doses of implanted silenium, the rules governing the amphoteric nature (acting as either a donor or acceptor) of Group VI impurities, the diffusion tails of Group IV impurities and the activation of deep-level impurities in semi-insulating materials.

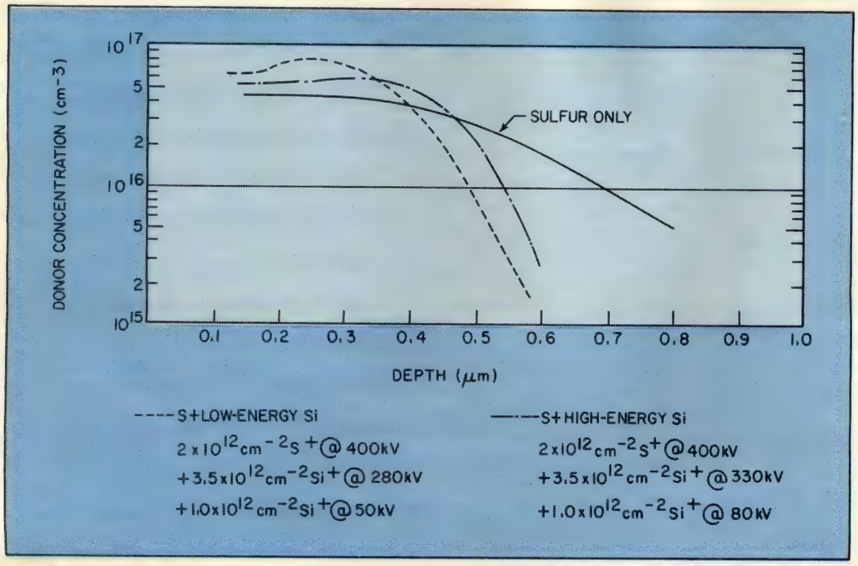
The results at Varian may signify the beginning of a new phase in GaAs technology. Yoder is optimistic about the effect of the new processing on such projects as a one-chip GaAs microwave, superheterodyne receiver that is under development at Rockwell International (Anaheim, CA).

Sid Adlerstein

The source of semi-insulating properties

Yoder offers the following explanation for the semi-insulating property of GaAs substrates grown by standard boric-oxide-liquid encapsulated (LEC) melts: The ionic bond between boron and arsenic atoms is very weak, and no evidence exists for a true covalent bond. Therefore, when a boron atom occupies a gallium site in the GaAs lattice, the four adjacent arsenic atoms are held by (at most) only three of their normal four bonds. The effect may be more pronounced, if, as evidence indicates, the impurities in GaAs are not distributed randomly but in clusters. Each arsenic atom clustered about a boron atom may itself be surrounded by four boron atoms—leaving the arsenic atom with essentially no bonding.

The many arsenic vacancies, either by themselves or in combination with other impurities, form acceptors deep within the material. These acceptors compensate for any background donors—creating a semi-insulator.



Sulfur, when implanted alone, diffuses deeply into annealed host GaAs material. Co-implantation of silicon with the sulfur ensures that the diffusion does not tail off into the bulk GaAs, so long as the concentration of the implanted silicon is greater than the sulfur's. Lower-energy Si^+ implants confine greater sulfur concentrations closer to the surface.

PLL programming gives fine resolution

Direct programming of two phase-locked loops (PLL) underlies a new frequency synthesis technique for designing precision, low-cost signal generators. Frequency synthesis allows 1-Hz resolution over a 1-Hz to 1.999999-MHz range, without using a large number of PLLs.

Through a patented technique from Comstron Corp. (Freeport, NY) called direct programmed differential synthesis, the divide-by-N counters in both loops contain alterable division numbers. These numbers consist of a constant divisor plus inputs from BCD counters connected to the instrument's tuning dial.

As shown in the system block diagram, a main PLL and a vernier PLL feed outputs into a single mixer. The mixer's output frequency, F_o, is the difference between the reference frequencies of the two PLLs. The reference frequencies (otherwise known as tuning increments f_m and f_v) are 1 kHz for the main PLL and 0.999 kHz for the vernier. If the division number of the main PLL increases or decreases by 1 (as a result of moving the tuning dial), the vernier PLL changes to correspond. No matter what the dial setting, the mixer output always shows a 1-Hz difference frequency.

The PLLs use internal 4-kHz loop reference frequencies, for fast programming and reduced crosstalk between loops.

The vernier loop is a low-noise PLL with a frequency phase comparator. A highly accurate and stable 7.992-MHz crystal oscillator is divided by 2000 to make a reference frequency very close to 4 kHz—3.996 kHz.

Two components make up the division number of the Vernier's divide-by-N_2 counter: One is a constant of 4000, the other is the three least significant digits (F_2, F_1 and F_0) of the desired output frequency, i.e., $(4000 + F_2F_1F_0)$. These three digits are the programmed digits, generated from the setting of the tuning dial via the up/down BCD counter. At the vernier output, ($4 f_v$) a 16 to 20-MHz signal appears, at a 3.996-kHz sampling rate. After passing through a divide-by-4 circuit and a bandpass filter, this signal becomes the tuning increment f_v of 0.999 kHz at the RF port of the mixer.

The main PLL operates like the vernier, except that the division number for the divide-by-N_1 counter is,

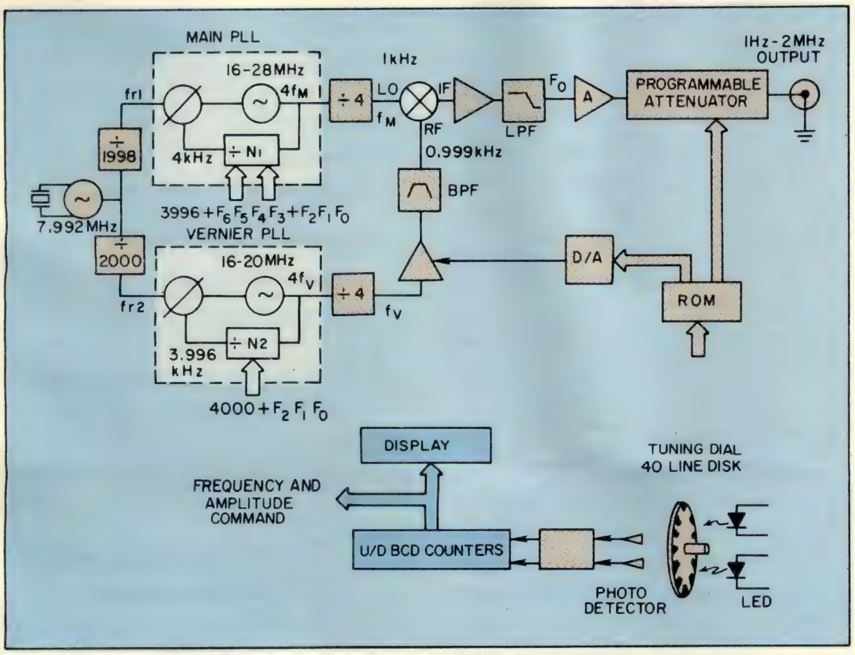
$(3996 + F_6F_5F_4F_3 + F_2F_1F_0)$,

where 3996 is the loop constant, F_6 through F_3 are the four most significant output digits, and F_2 through F_0 are the three least significant digits of the output frequency. The output of the main PLL is divided by 4 and fed to the mixer's LO port as a 16 to 28-MHz signal, at a 1-kHz sampling rate.

The selection of the proper PLL sampling rate involves a tradeoff that directly affects the system phase noise. Phase noise analysis indicates that 1 kHz is the lowest rate that meets cost and performance objectives.

The PLL/direct programming technique is applied in Comstron's Model 1002 precision signal source.

Gene Heftman

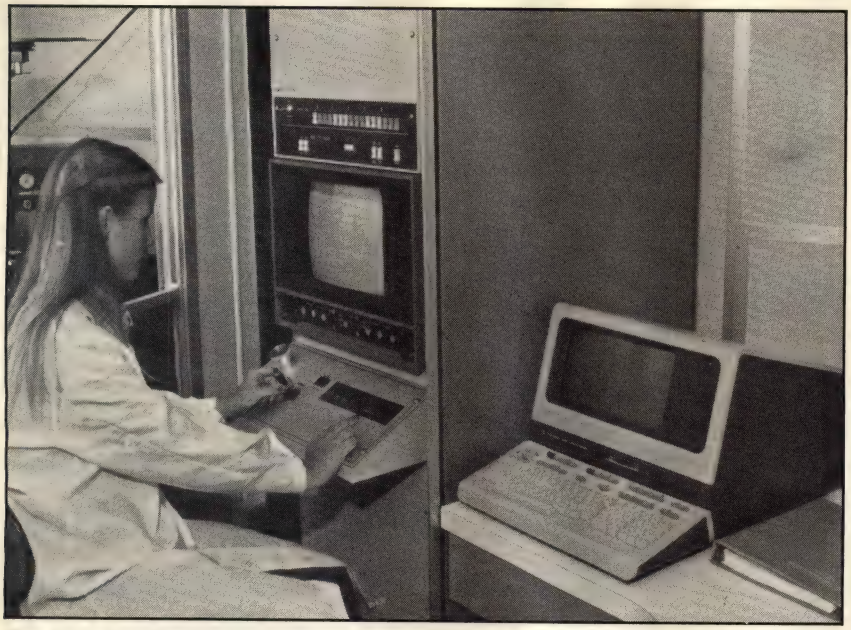


Frequency control in a signal generator takes on a new look with this patented dual-phase lock-loop scheme. Comstron Corp. uses the new technique in the Model 1002 precision signal source to provide high resolution on outputs from 1 Hz to 2 MHz.

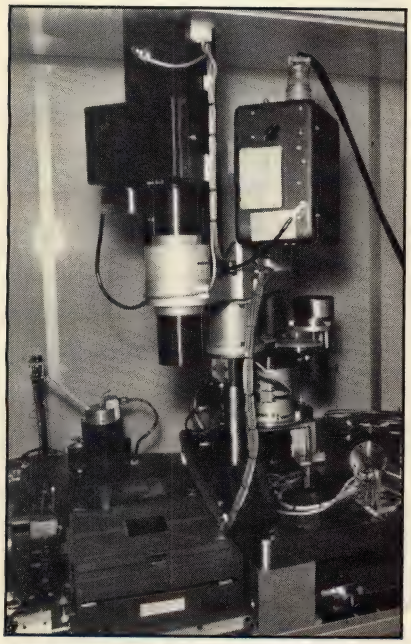
Interferometer places wafers within 0.25 μm

The silicon chip revolutionized the computer industry; now the computer is about to revolutionize the silicon chip. Under minicomputer control, a laser interferometer positions silicon wafers with an accuracy of ±0.25 μm for direct-reticle-to-wafer imaging. Although hardly out of the laboratory at Electromask (Woodland Hills, CA), computer-controlled interferometry could become a standard approach, according to Rick Brewster system project manager.

Electromask's 700 SLR wafer stepper provides a line resolution



The high-density circuits required for the new VLSIs become practical, with the computer-controlled wafer stepper. Wafer-to-reticle alignment can be observed directly on the computer's CRT display. Once the wafer is aligned, all system functions, such as wafer loading and reticle handling, are automatically controlled by the computer.



The Electro-mask 700 SLR wafer-stepping photomask system can reproduce the details of a microcircuit with a resolution of better than 1 μm. Wafer-to-reticle alignment takes place through the same lens used for reduction and exposure. An HP-1000 computer system with laser interferometry helps control wafer positioning.

of 1 μm, instead of the 2 to 3 μm given by conventional projection.

Wafer loading and reticle handling (up to 25 wafers per cassette) and wafer levelling (for 3, 4 and 5-in. wafers) are all automatically controlled by the machine's minicomputer. Except for an initial alignment of the wafer, the system runs without operator intervention.

A through-the-lens technique lets the operator align reference targets on the reticle and wafer, using the same lens that does the reduction and exposure. Once the operator has aligned the wafer, the x and y coordinates are stored in the computer, which automatically makes scale factor adjustments, calculates angular corrections and rotates the wafer to the right position.

The first systems were directed by hardwired controllers. But computer control makes the system more flexible, accurate and easier to operate and set up. Because programs are kept on paper or magnetic tape, the setup can be changed quickly for new semiconductor devices; arrays can be switched quickly from square to circular patterns; and scale factors can be varied easily to accommodate device circuit-design changes.

The system makes extensive use of Hewlett-Packard hardware: a general-purpose HP Series 1000 minicomputer, HP's laser interferometry system and all the necessary computer peripherals. The HP-1000's powerful instruction set includes such operations as floating-point and integer arithmetic, and automatic parity checking.

Many of the interface boards, such as CRT and tape-drive interfaces, are off-the-shelf HP products. Others, such as the laser pulse-converter board are modified from standard products by HP. A few special boards are built by Electromask.

Electromask also provides the software, which is usually customized to meet user specifications. It is written entirely in HP's assembly language. Although this language is more difficult to work with than a high-level language, it converts directly and more efficiently to the machine code.

To speed the software design, each software package is created from a series of relocatable software modules: many are standard HP-library routines. Each program module in the master-software package includes several routines for specific tasks that can be intermixed by a jump instruction as needed.

An executive model, called EMIRC, handles all communications with the operator, including system initialization and termination, job-data creation and program modification. The executive also generates helpful prompts for entering data and prevents errors by keeping the operator fully informed of the system's status.

Morris Grossman

Econo/Mate.

More power for your power supply dollar.

Power/Mate's new Econo/Mate open frame linear power supplies now pack a bigger punch. They offer up to 33% more power from the same case size than many competitive models, at no increase in cost. That means you can achieve even greater reliability from the Econo/Mate by operating at a percentage of full load. Or, alternatively, pack more power in a smaller space.

You get more features as standard. OVP on all 5 volt outputs, standard. Dual 105-125/210-250 VAC inputs on all supplies, standard. Remote sense capability on all supplies is standard, except EMA-A and ETA-B.

Fifty Econo/Mate models from 5 to 24 VDC, up to 25 Amps. Single, dual, and triple outputs including the popular disc drive supplies. Think of them as the new old standby.

ingle Output Supplies

odel	Output	Price
MA-5AV	5V @ 1.2A	$ 27.00
MA-5BV	5V @ 3.0A	$ 35.00
MA-5CV	5V @ 6.0A	$ 59.00
MA-5CCV	5V @ 11.0A	$ 74.00
MA-5DV	5V @ 15A	$ 94.00
MA-5FV	5V @ 25A	$149.00
MA-6A	6V @ 1A	$ 27.00
MA-6B	6V @ 2.8A	$ 35.00
MA-6C	6V @ 5.5A	$ 59.00
MA-6CC	6V @ 10A	$ 74.00
MA-6D	6V @ 13A	$ 94.00
MA-6F	6V @ 22A	$149.00
MA-9/10A	9V @ 0.75A 10V @ 0.75A	$ 27.00
MA-9/10B	9V @ 1.8A 10V @ 1.8A	$ 35.00
MA-9/10C	9V @ 3.8A 10V @ 3.6A	$ 59.00
MA-9/10CC	9V @ 8A 10V @ 7.5A	$ 74.00
MA-9/10D	9V @ 10.5A 10V @ 10.0A	$ 94.00
MA-12/15A	12V @ 0.5A 15V @ 0.5A	$ 27.00
MA-12/15B	12V @ 1.5A 15V @ 1.3A	$ 35.00

Model	Output	Price
EMA-12/15C	12V @ 3.0A 15V @ 2.8A	$ 59.00
EMA-12/15CC	12V @ 6.0A 15V @ 5.0A	$ 74.00
EMA-12/15D	12V @ 8.8A 15V @ 8.0A	$ 94.00
EMA-12/15F	12V @ 16A 15V @ 15A	$149.00
EMA-18/20A	18V @ 0.4A 20V @ 0.4A	$ 27.00
EMA-18/20C	18V @ 2.5A 20V @ 2.3A	$ 59.00
EMA-18/24B	18V @ 1.2A 20V @ 1.0A 24V @ 1.0A	$ 35.00
EMA-18/24CC	18V @ 4.5A 20V @ 4.0A 24V @ 3.8A	$ 74.00
EMA-18/24D	18V @ 7.1A 20V @ 7.0A 24V @ 6.5A	$ 94.00
EMA-24A	24V @ 0.4A	$ 27.00
EMA-24C	24V @ 2.3A	$ 59.00
EMA-24F	24V @ 12A	$149.00

Dual Output Supplies

Model	Output 1	Output 2	Price
ETA-5BV	5V @ 1.2A	5V @ 1.2A	$ 48.00
ETA-5CV	5V @ 3.0A	5V @ 3.0A	$ 68.00
ETA-5DV	5V @ 6.0A	5V @ 6.0A	$ 96.00
ETA-515BV	5V @ 1.2A	12V @ 0.5A 15V @ 0.5A	$ 48.00
ETA-515CV	5V @ 3.0A	12V @ 1.5A 15V @ 1.3A	$ 68.00
ETA-515DV	5V @ 6.0A	12V @ 3.0A 15V @ 2.8A	$ 96.00
ETA-524BV	5V @ 1.2A	24V @ 0.4A	$ 48.00
ETA-524CV	5V @ 3.0A	24V @ 1.0A	$ 68.00
ETA-524DV	5V @ 6.0A	24V @ 2.3A	$ 96.00
ETA-12/15B	12V @ 0.5A 15V @ 0.5A	12V @ 0.5A 15V @ 0.5A	$ 48.00
ETA-12/15C	12V @ 1.5A 15V @ 1.3A	12V @ 1.5A 15V @ 1.3A	$ 68.00
ETA-12/15D	12V @ 3.0A 15V @ 2.8A	12V @ 3.0A 15V @ 2.8A	$ 96.00

Triple Output Supplies

Model	Output 1	Output 2	Output 3	Price
ETR-142EV	5V @ 6A	12V @ 1.5A 9V @ 1.2A 5V @ 0.8A	12V @ 1.5A 15V @ 1.3A	$115.00
ETR-122EV	5V @ 6A	+12V @ 1.5A +15V @ 1.3A	−12V @ 1.5A −15V @ 1.3A	$115.00
ETR-132EV	5V @ 6A	18V @ 1.0A 20V @ 1.0A 24V @ 1.0A	12V @ 1.5A 15V @ 1.3A	$115.00

Disk Drive Power Supplies, Dual Output

Model	Output 1	Output 2	Price
ED-512AAV	+12V @ 1.1A (Av) +12V @ 1.7A (Pk)	+5V @ 0.7A	$ 41.00

Disk Drive Power Supplies, Triple Output

Model	Output 1	Output 2	Output 3	Price
ED-524BV	24V @ 1.5A (Av) 24V @ 1.7A(Pk)	+ 5V @ 1A	−5V @ 0.5A	$ 72.00
ED-524CV	24V @ 3.0A (Av) 24V @ 3.4A (PK)	+ 5V @ 2.5A	−5V @ 0.5A	$ 94.00
ED-524DV	24V @ 5A (Av) 24V @ 6A (PK)	+ 5V @ 3A	−5V @ 0.6A	$125.00

Econo/Mate Specifications

AC input. 105-125/210-250VAC at 47-63 Hz. Derate output current 10% for 50 Hz operation.

DC output ratings. See Voltage/Current rating chart. Adjustment range ±5% minimum.

Line Regulation. 0.05% for a 10% input voltage change.

Load Regulation. ±0.1% for a zero to full load change.

Stability. 0.05% for 24 hours after warm up.

Output Ripple. Better than 1mV RMS: 3mV peak to peak typical.

Remote Sense. Standard on all Econo/Mate supplies except EMA-A and ETA-B cases.

Polarity. May be either positive or negative with respect to ground or 'floating' up to 300 VDC.

Overshoot. No voltage overshoot on turn-on, turn-off or power failure.

Temperature Rating. 0°C to 40°C full rated power, derated linearly to 60% at 71°C for EMA, ETA and ETR, and full rated 0°C to 50°C, derated linearly to 50% at 71°C for ED supplies.

Storage Temperature. −50°C to +85°C.

Temperature Coefficient. ±0.005%/°C typical. ±0.02%/°C maximum.

Transient Response. Occurs within 50 microseconds for a 50 to 100% load change.

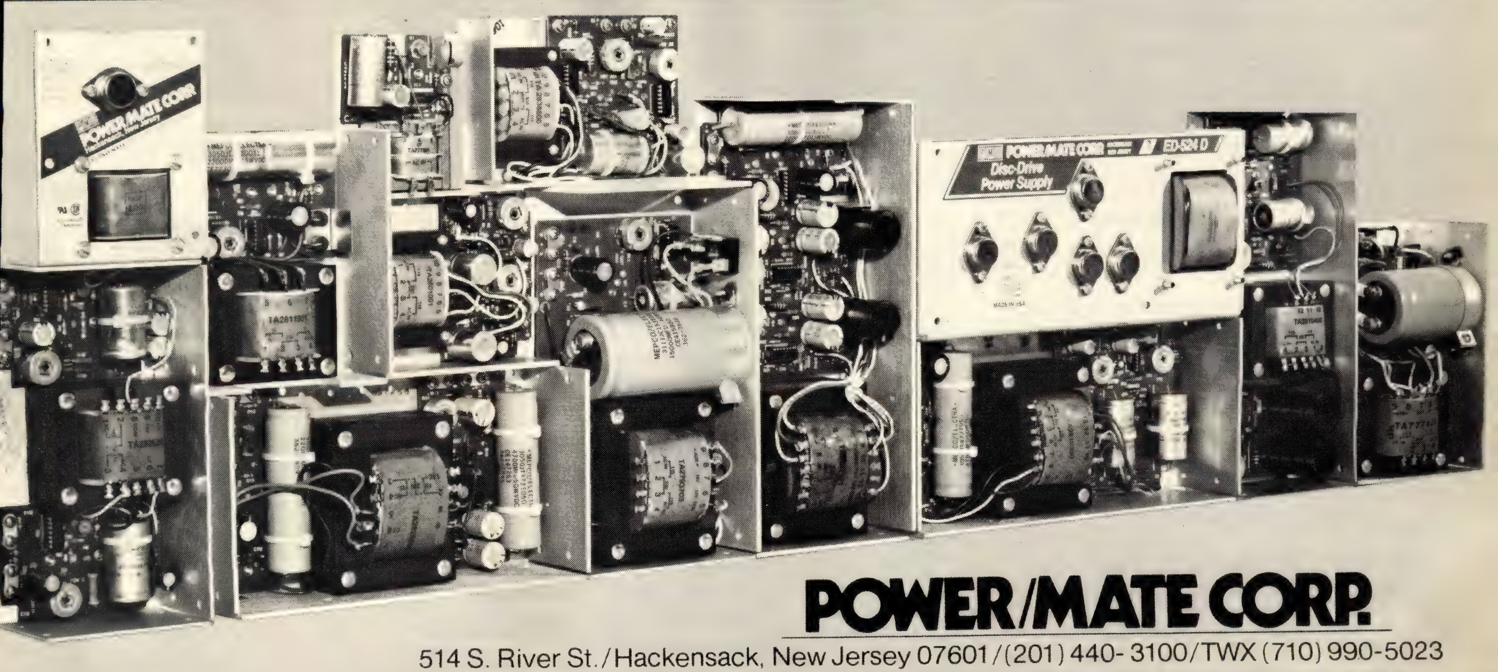
Short Circuit and Overload Protection. Self-restoring current limiting (foldback type).

Overvoltage Protection. OVP is standard on all 5V outputs, set at 6.2V ±0.4V. OVP modules are available for all other output voltages.

UL Recognized. Econo/Mate Supplies are listed as a recognized component in Underwriters' Laboratories recognized component index. (UL 47B, File No. E 45485).

CSA Recognized. Econo/Mate supplies are listed as a certified component in Canadian Standards Association's recognized component index. (LR 34-518).

Model	Mounting Surfaces	Dimensions
EMA-A	2	3.78" x 3.03" x 2.15"
EMA-B	3	4.87" x 4.00" x 2.07"
EMA-C	3	5.62" x 4.87" x 2.95"
EMA-CC	3	7.03" x 4.90" x 3.23"
EMA-D	4	9.00" x 4.87" x 3.20"
ETA-B	2	4.90" x 4.03" x 2.25"
ETA-C	4	7.90" x 4.03" x 2.93"
ETA-D	4	9.40" x 4.90" x 3.23"
ETR-E	4	11.00" x 4.90" x 3.23"
EMA-F	3	16.75" x 4.87" x 4.94"
ED-AA	3	6.50" x 4.00" x 2.07"
ED-B	4	10.25" x 4.00" x 2.95"
ED-C	4	11.00" x 4.87" x 3.20"
ED-D	4	11.00" x 4.87" x 3.20"



POWER/MATE CORP.

514 S. River St./Hackensack, New Jersey 07601/(201) 440-3100/TWX (710) 990-5023
3303 Harbor Blvd./Costa Mesa, CA 92626/(714) 957-1606/TWX (910) 595-1766

The world's largest supplier of quality power supplies.

CIRCLE NO. 19

Voice recognition comes in terminals and systems

Systems designers who prefer voice input as an alternative to keyboards for data entry can now turn to devices that respond to as many as 250 words—and research efforts claim the vocabulary could run as high as 1000 words. The equipment itself is varied. Terminals can use syntax formats designed into their software or special speech-recognition boards can be designed into dumb terminals.

The problem with data-entry technology is that it has not kept pace with the dramatic processing advances made by computer technology. The major reason is that whether the data-entry device is a CRT terminal or a keyboard, it still requires the operator to use his hands and eyes to perform the data capture and entry function. Voice recognition, on the other hand, captures data interactively.

One new computer terminal recognizes 180 words a minute without having to pause the 0.1 to 0.2 seconds between words or syllables that other terminals need to distinguish word ends and certain intraword stops. That entry rate is more than twice the rate attainable by equipment that recognizes isolated words and is far beyond most keyboard-entry speeds.

The Quiktalk terminal from Threshold Technology, Inc. (Delran, NJ) features syntax formats designed into its software that enable speakers to enter data with an accuracy of 99% at the entry rate of 180 words/min.

Another way to implement speech recognition is to incorporate a speech-recognition board into a CRT terminal. The first speech-recognition board specifically designed for a CRT terminal is ready from Heuristics, Inc. (Sunnyvale, CA). Designated the VOCON 5000 and microprocessor-based, the PC board transforms the Lear-Siegler (Anaheim, CA) ADM-3A dumb terminal into a voice-actuated video-display terminal. A noise-canceling microphone rounds out the system.

Meanwhile, a voice-recognition module (VRM) from Interstate Electronics (Anaheim, CA) can recognize as many as 100 words or short phrases. It's a single-board system equipped with parallel interfaces.

When the VRM operates in the host mode, the application program written for the operation prompts the operator and controls the VRM functions. (The VRM is compatible with Fortran, Pascal and Basic.) In the stand-alone mode, all functions are controlled by switch setting or by TTL levels. These control functions are brought to pin connections on the board.

Talk to a computer

To demonstrate the capabilities of its intelligent voice-recognition terminal—and satisfy curiosity seekers—Interstate Electronics has made its terminal available by telephone. Simply dial (714) 635-2820 between 5:00 pm and 8:00 am (Pacific Coast Time) and the voice terminal will answer.

After the terminal says "Repeat after me," it will say certain words three times. Do likewise. This enables the terminal to recognize your voice. After the words have been repeated, the voice-data entry system will enter the voice-recognition mode. A dialogue then ensues:

You say	It says
Interstate	Voice-data entry system
Application	User-programmable
Data entry	Natural language
Vocabulary	Maximum 900 words
Butter	Parkay
Parkay	Butter

When you are through, say "Goodbye." The terminal says, "Are you ready to stop talking?" If you say "Yes," the terminal will simply say "Goodbye." If you say "No," the terminal responds with "OK—you may now say any word in the vocabulary. Please say goodbye before terminating the call."

A total voice response system, packaged with its own computer for remote communications and software development systems, is available from Perception Technology (Winchester, MA). LSI-11 based and RS-232C-compatible, the PTC BT-2 is equipped with eight channels of speech output and 30 words of vocabulary. The maximum configuration is 64 input and 64 output channels and 256 words.

Meanwhile, the word from IBM's research division (Yorktown Heights, NY) is that composing spoken sentences from a 1000-word vocabulary can be 91% accurate. Currently, the research effort is aimed at recognizing continuous speech without the aid of artificial pauses between words. An acoustic processor (AP) consisting of a signal processor followed by a pattern recognizer, serves as a data compressor.

The signal processor first digitizes the speech at a 20-kHz sampling rate. Then, every centisecond, a discrete Fourier transform (DFT) is computed from a 2-centisecond segment of the sampled waveform.□

Len Yencharis

Splice system cuts field fiber losses to 0.15 dB

A do-it-yourself splicing procedure for silica communications-grade optical fiber not only provides coupling losses on the order of 0.15 dB, but also helps bring

THE WORLD'S FIRST COMPLETE 10-BIT, 20MHz VIDEO ADC.

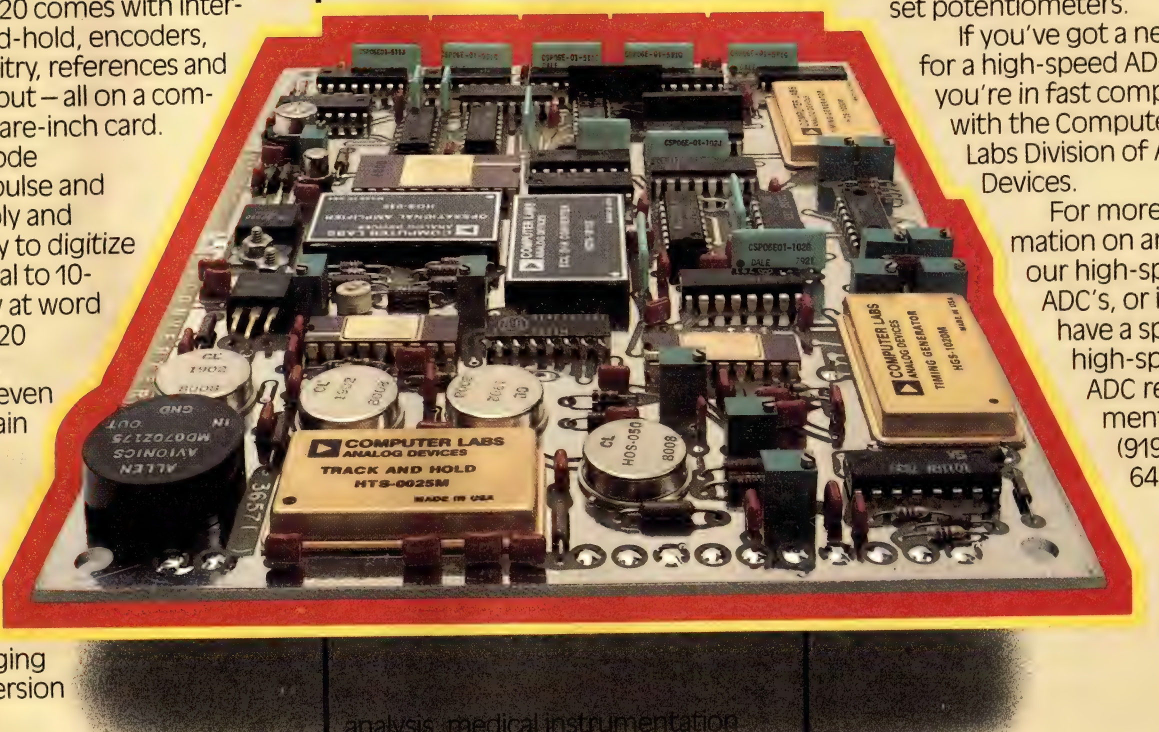
IT'S FIRST, FAST AND AFFORDABLE.

Now you can get a high resolution video A/D converter right off the shelf. And our new MOD-1020 is surprisingly affordable.

EVERYTHING YOU NEED ON ONE CARD.

Our MOD-1020 comes with internal track-and-hold, encoders, timing circuitry, references and latched output – all on a compact 35-square-inch card. Add an encode command pulse and power supply and you're ready to digitize a video signal to 10-bit accuracy at word rates up to 20 MHz.

We've even provided gain and offset potentiometers. And our unique digital correcting subranging (DCS) conversion technique will eliminate errors common with other subranging type ADC's.



IT'S IDEAL FOR ALL SORTS OF HIGH SPEED APPLICATIONS.

Radar digitizing, digital communications (baseband digitizing), composite color TV digitizing, spectrum analysis, medical instrumentation (including digital x-ray) are just a few of the many applications for our ultra high-speed ADC.

TWO OTHER FAST ADC'S AT REDUCED COST.

If you're looking for ADC's with 5 MHz word rates, look no further. Our 10-bit MOD-1005 and 12-bit MOD-1205 may be just right. They're both TTL compatible, require no external parts and only occupy 27 square inches. And like our MOD-1020, they both include DCS, and gain and offset potentiometers.

If you've got a need for a high-speed ADC, you're in fast company with the Computer Labs Division of Analog Devices.

For more information on any of our high-speed ADC's, or if you have a special high-speed ADC requirement, call (919) 292-6427.

ANALOG DEVICES
COMPUTER LABS

WAY OUT IN FRONT.

Analog Devices, Inc., Box 280, Norwood, MA 02062; East Coast: (617) 329-4700; Midwest: (312) 894-3300; West Coast: (714) 842-1717; Texas: (214) 231-5094; Belgium: 031/37 48 03; Denmark: (02) 84 58 00; England: 01/94 10 46 6; France: 687-3411; Germany: 089/53 03 19; **Japan: 03/26 36 82 6; Netherlands:** 076/879 251; Switzerland: 022/315760; and representatives around the world.

CIRCLE NO. 171

such low-loss splicing capability to the field. Developed by the Optoelectronics group of Thomas and Betts (Raritan, NJ), the low-profile splice harnesses a precision V-groove alignment scheme, an optical adhesive and heat-shrink tubing (instead of more conventional elastomerics) to hold the fibers in the groove.

Meanwhile, extensive research at T&B/Optoelectronics using interferometry confirms not only that a clean fiber break is essential to a low-loss connection but also that fiber ends must be perpendicular to the fiber length.

While GTE Laboratories (Waltham, MA) announced a low-loss cylindrical connector at the Cherry Hill Connector Symposium last fall (ELECTRONIC DESIGN, Oct. 11, 1979, p. 36), the commercial version has not been introduced and no field data have been reported. GTE's "field-installable" splice relies on elastomers inside a metal or hardened plastic cylinder to provide the V-groove alignment. Coupling losses in the range of 0.07 to 0.24 dB with 0.15 dB typical have been reported in laboratory tests using 125-μm cladding-diameter (63-μm core diameter) communications-grade fiber, and index-matching fluid.

In the splicing system developed by T&B/Optoelectronics, however, the fibers are aligned in a V-groove on a small (0.062-in. OD, 2-cm-long) brass pin. Several versions of the splice are available for glass fibers having 125 to 250-μm cladding diameters. The fiber ends are aligned under a microscope and joined with an index-matching optical adhesive, which has a refractive index of 1.56 and a cure time of one minute under ultraviolet light. Heat applied to a partially shrunken polyolefin outer tube over the brass pin holds the fibers permanently in the groove and relieves strain.

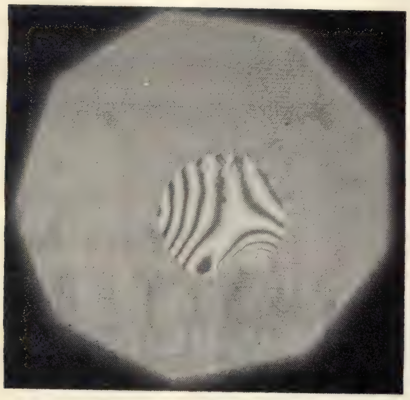
The quality of any splice, however, hinges on the smoothness of the fiber faces and their perpendicularity, according to the company. Many scribe-and-break tools for silica fibers, however, may not provide consistently smooth or perpendicular breaks. The further the face of the fiber end is from a perpendicular angle, moreover, the higher the losses. According to Scott Gordon, T&B/Optoelectronics' manager, fiber faces that are more than 3° off perpendicular will provide losses exceeding 0.5 dB.

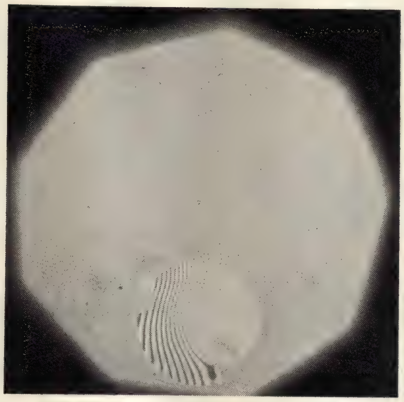
A fiber's perpendicularity can be determined using an interferometer. In the technique, first harnessed to fiber optics by Gordon, reflected and filtered light on a fiber end is compared with the same light reflected from a flat reference surface. White light from a high-pressure xenon lamp is filtered using a red interference filter with a 100-Å grid. (Alternately, sodium light can be filtered at 596 nm.) With this method of applying filtered light, angular differences between the fiber end and the reference surface appear as dark lines or fringes on the fiber end when viewed under a high-power microscope. These fringes can be interpreted as a topographical map of the fiber. A smooth surface is indicated by parallel lines; surface angle by number of fringes.

For fibers of 125-μm diameter illuminated with a 6500-Å light, each degree of difference between the fiber face and the reference surface will produce about eight fringes on the fiber surface.

Fiber inspections using the interferometer reveal that a large number of scribe-and-break tools for glass fibers will not provide a highly perpendicular surface. The reason, Gordon believes, is that many scribe-and-break tools tend to bend the fiber around the circumference of an imaginary circle as the fiber is broken. However, tools relying on a straight pull produce generally closer-to-perpendicular fiber breaks.□

Stephan Ohr





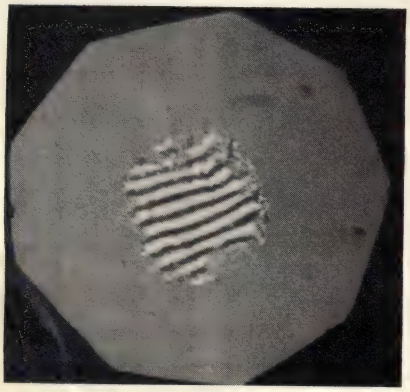


Chart a fiber break precisely with interferometry. Both the top-left and bottom-left photos show good breaks, less than 1° off perpendicular, but with roughness on the cladding. The top photo also shows stress fringes where the fiber was scored (toward the bottom of the circle), while the bottom photo indicates microscopic silica particles on the face of the fiber. The above photo shows a basically smooth break (typical of many scribe-and-break operations), which deviates substantially from the perpendicular because of a crack in the fiber itself (lower right).

Announcing high performance Z-80A® in-circuit emulation for your Intellec® development system!

Now, from RELMS,® the incredibly powerful Z-80A SPICE,® in-circuit emulator.

If you are designing Z-80 microprocessor-based products, and own or use an Intellec Microcomputer Development System, then SPICE, from RELMS, is the most powerful development and debugging tool available.

This proven design aid lets you emulate in real-time Zilog's Z-80 and Z-80A microprocessors. SPICE is completely compatible and plugs directly into the Intellec 800, 888, and Series II models 220 and 230.

SPICE lets you develop Z-80 software utilizing its powerful relocatable macro assembler. Hardware can be developed at 4 MHz.

Z-80 SPICE boasts the new concept of in-circuit emulation called *breakregion,*™ allowing you to halt emulation and isolate a hardware fault or a software bug.

SPICE lets you select machine cycle or instruction trace. SPICE lets you collect virtually unlimited trace history on disk. With SPICE, you can test your product with disk-based command files automatically, and debug your prototype in real-time wherever you may be in the development cycle.

Z-80 SPICE is only available from RELMS—Relational Memory Systems.

Upgrade your Intellec 800 or 888 to Z80A capability with SAM—RELMS' powerful System Adaptor Module.

Z-80ASAM retains compatibility with all Intellec 800 hardware and software features for 8080A and 8085. PL/M, FORTRAN-IV, BASIC and 8048 cross assemblers run at 4 MHz.

If you are an Intellec 800 or 888 user, let RELMS' Z-80ASAM (System Adaptor Module) boost your power to the Z-80 or Z-80-A level. Replace the 8080 processor card in your Intellec system with SAM and you'll have all the architectural features of the Z-80 CPU ready to get you developing Z-80 software fast, at 4 MHz.

RELMs' Z-80 SAM System Adaptor Module comes complete with Z-80 Relocatable Macro Assembler, Macro Monitor and Executive Monitor.

Expand your Intellec capacity with macro assemblers.

RELMS' five relocatable macro-assemblers can help you increase the universality of your Intellec system. They are compatible with Fairchild, Motorola and Mostek Zilog language definition features, and produce an ISIS-II-compatible output.

F8/3870/3872 RMA	$500
6500/6501/6502 RMA	$500
6800/6801/6802 RMA	$500
Z80 RMA	$500
6809 RMA	$500

Relational Memory Systems, Inc.
1180 Miraloma Way
Sunnyvale, CA 94086
(408) 732-5520
TWX 910 379 0014

relms

CIRCLE NO. 21

SAM and SPICE sound really nice, RELMS!

☐ I want more ☐ SPICE information ☐ SAM information ☐ Assembler information immediately! Call me at (_____)______-__________.

☐ Please send me your SPICE brochure and data sheet. ☐ Please send me your SAM brochure and data sheet. ☐ Please send me your Relocatable Macro-Assembler data sheet.

☐ I'm interested in all of RELMS' high performance development tools for my application, which is:

____

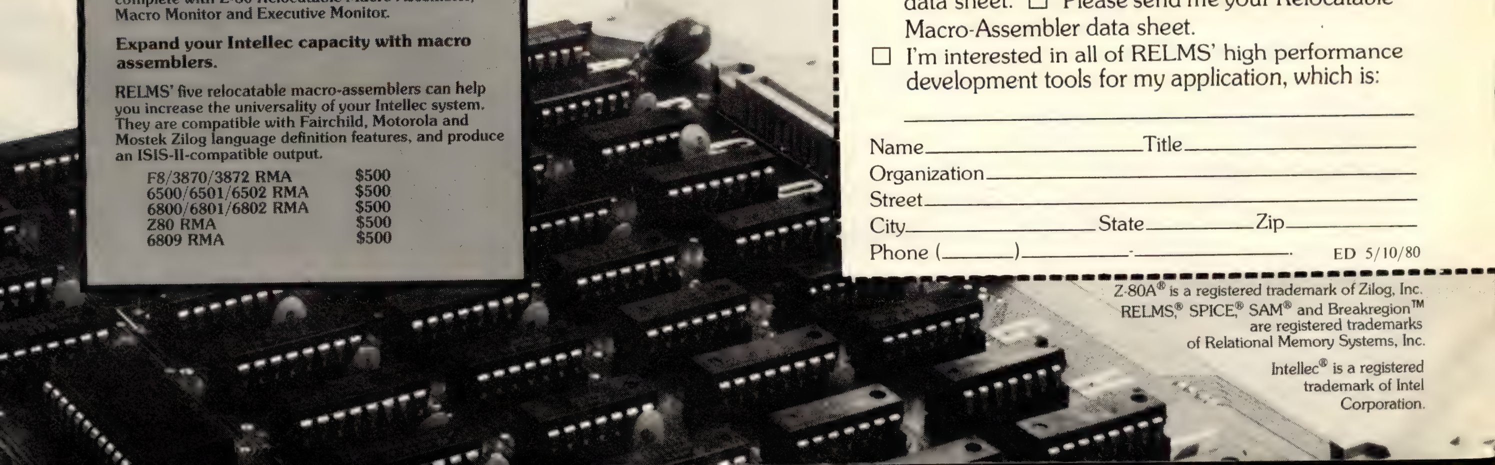
Name________________ Title________________

Organization____________________________

Street____________________________

City____________ State________ Zip________

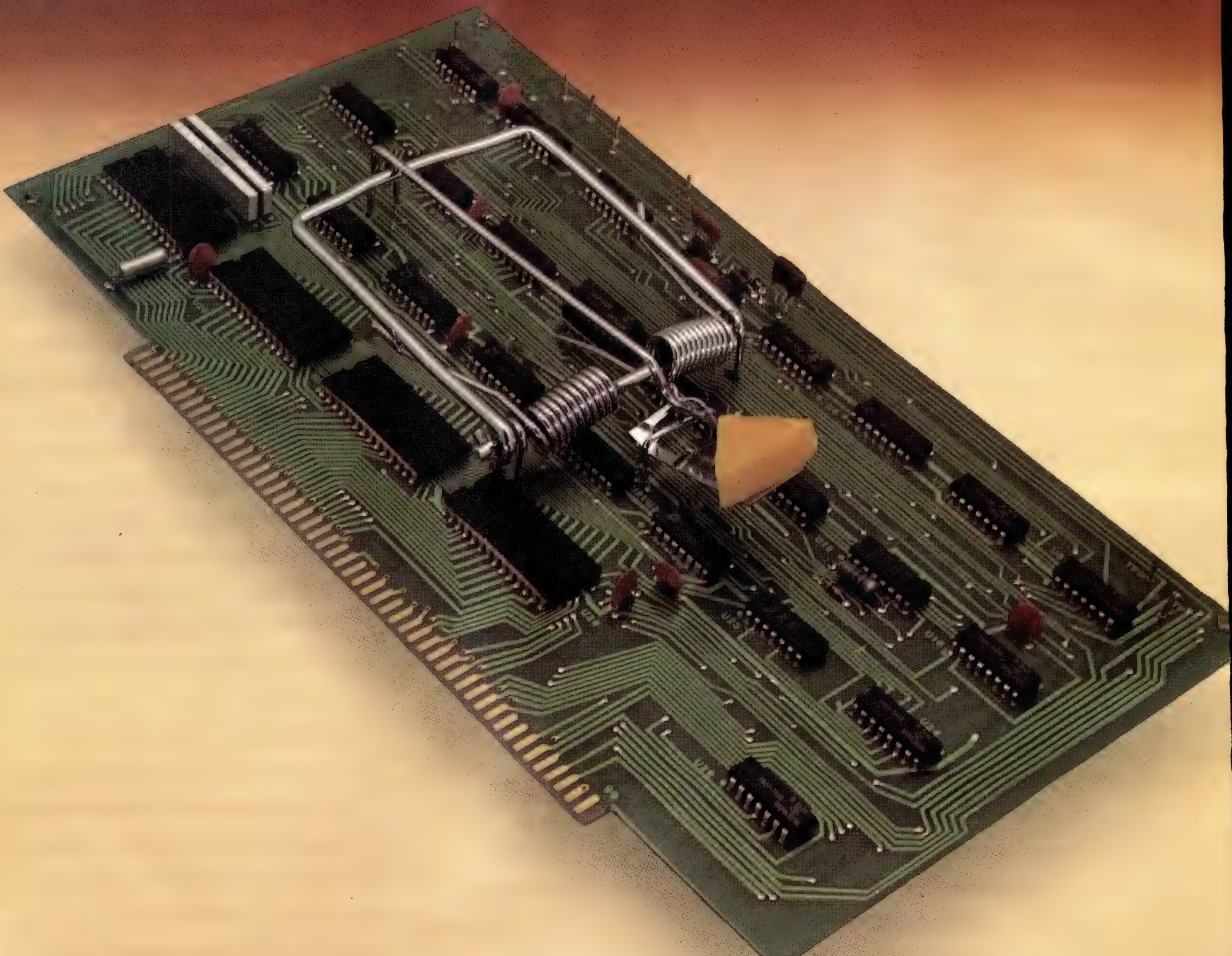
Phone (_____)______-__________. ED 5/10/80



Z-80A® is a registered trademark of Zilog, Inc.
RELMS,® SPICE,® SAM® and Breakregion™ are registered trademarks of Relational Memory Systems, Inc.

Intellec® is a registered trademark of Intel Corporation.

The best way to catch a glitch is to trigger on it…



with HP's 1615A Logic Analyzer.

Glitches. They're hard to see and difficult to trap. They can appear almost anywhere. And you can seldom predict when they'll cause trouble. But when they do, HP's 1615A Logic Analyzer is the way to catch them. Here's why:

1) It's the one analyzer that triggers on glitches. It can actually differentiate between valid signals and troublesome glitches. Then trigger on a glitch so you can see where it is and what your system was doing when it occurred.
2) With the 1615A's simultaneous state and timing capability plus interactive triggers, you can capture both state flow and timing relationships. That means you can trigger on a glitch and view program execution. Or, you can trigger on the glitch and view control lines to see what may have toggled simultaneously. Either way, it's a powerful technique to relate a glitch to system operation.

Simultaneous synchronous/asynchronous analysis

Since today's systems utilize both synchronous and asynchronous activity, your analyzer should be able to analyze both simultaneously. And HP's 1615A does just that. For example, you can analyze:

Memory transactions related to handshake signals

DMA and control-line relationships

Control sequence for I/O port data

Activity on the input and output of I/O ports

And, of course, the 1615A, with 24 channels, lets you analyze relationships between activity on synchronous buses such as combinations of address, data and I/O.

Glitches aren't the only faults

Since there are other failure modes, you want more than glitch triggering and simultaneous synchronous/asynchronous analysis in a logic analyzer. And HP's 1615A gives you a lot more. Such as pattern triggering for isolating program or data related faults; occurrence triggering for debugging complex loop problems; menu formats for easy set-up and analysis; and more.

For more information

There's much more to the 1615A ($6800*) and it uses in system design and troubleshooting. For complete details and a copy of an application note on glitch detection, write to: Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

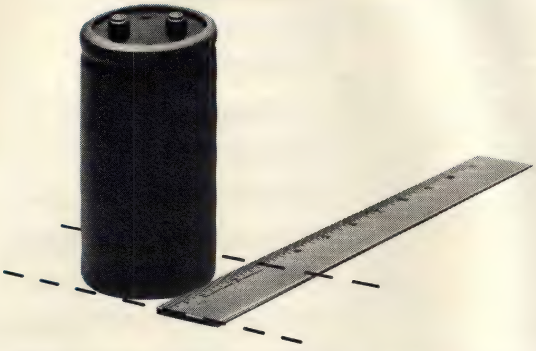
*Domestic U.S.A. price only.

080/1

HEWLETT PACKARD

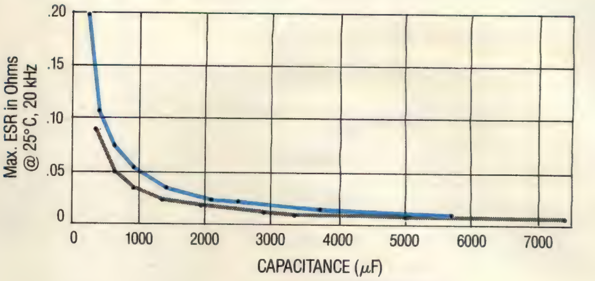
CIRCLE NO. 22

HIGH CAPACITANCE PER CASE SIZE



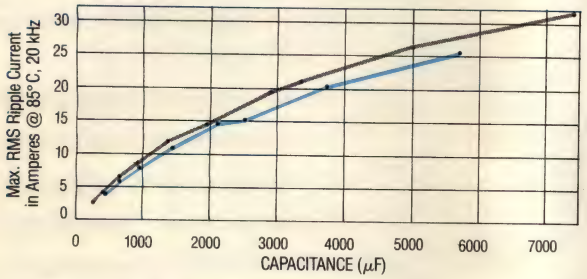
Values as high as 7,400μF @ 200 VDC in a 3″ x 5.625″ case.

LOW ESR



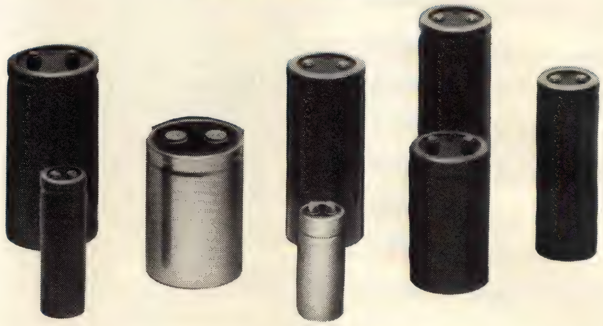
Curve plotted in gray represents capacitors rated at 200 VDC.
Curve plotted in blue represents capacitors rated at 250 VDC.

HIGH RIPPLE CURRENT CAPABILITY



Curve plotted in gray shows ripple current capability for capacitors rated at 200 VDC while curve plotted in blue shows ripple current limits for capacitors rated at 250 VDC.

A RATING TO MEET YOUR NEEDS



Sprague Type 623D Extralytic® Input Filter Capacitors are available in 20 standard ratings ranging from 260μF to 7400μF.

New Sprague Type 623D Input Filter Capacitors for switched-mode power supplies

Sprague's new Type 623D Extralytic® Capacitors have been expressly designed to provide superior performance in off-line switching-type applications . . . and they meet tight space and tight budget requirements.

A few of the prime advantages of these new capacitors are highlighted above. Most important, though, is the fact that you can select from standard ratings to zero-in on your power supply requirements without paying for costly specials that necessitate slower deliveries.

For detailed technical data, write for Engineering Bulletin 3461 to: Technical Literature Service, Sprague Electric Company, 347 Marshall St., North Adams, Mass. 01247.

4SE-9115R1

SPRAGUE®
THE MARK OF RELIABILITY

THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

a subsidiary of **GK Technologies** Incorporated

CIRCLE NO. 23

WashingtonReport

FCC abolishes AT&T regulation

After four years of study and regulatory proceedings, the stage is now set for AT&T to sidestep a 1956 consent decree with the Justice Department and involve itself in the burgeoning data processing and data communications market.

In a striking reversal of traditional thinking, the FCC voted 5-2 to abolish all regulations governing the communications giant—and the smaller General Telephone and Electric Corp. —except for basic and long-distance telephone service. There is only one catch: All unregulated activity must be handled by separate subsidiary companies that have only minimal connections to the parent firm, so telephone subscribers will not be forced to subsidize the new operations.

The FCC decision means that the telephone companies must separate telephone service from their other interests, such as equipment. After March 1982, regular phone subscribers must be given the opportunity to buy their phones or lease them under a separate billing agreement. Other terminal equipment, from data processing products to memory banks, will be treated the same way, with AT&T and GTE competing with firms already offering the equipment.

The commission's administrative action preempts a similar effort in Congress, led by Rep. Lionel Van Deerlin (D-CA). Van Deerlin, whose bill is stalled in the House, called the FCC's move "a home run." Not all parties to the debate surrounding the FCC vote were as optimistic as Van Deerlin; even proponents of deregulation expect the issue to be reexamined and ultimately settled in the courts.

Channel spacing stays at 10 kHz

The U.S. has failed to convince other Western Hemisphere nations to reduce the spacing between AM radio channels from 10 kHz to 9 kHz, at least for now.

At a conference on AM spectrum use, sponsored by the United Nations' International Telecommunications Union in Buenos Aires, Argentina, a proposal to make the spacing change ran into stiff resistance. Delegates decided to put off the question until their next session in November, 1981.

The narrower channels, already used everywhere but in the Western Hemisphere, would open up a dozen new broadcasting spots on the currently crowded AM band. This goal has long been espoused by both the U.S. National Telecommunications and Information Agency and by the FCC.

Study foresees regulatory problems from TV-satellite links

Within the next decade, millions of households around the world will be receiving television broadcasts directly from geostationary satellites, according to a study sponsored by the Federal Communications Commission. The situation will pose complex regulatory and technical challenges.

The FCC will have to decide whether to treat the domestic direct broadcast satellite (DBS) systems as common carriers, as broadcasters or as a special mix of the two—but, in any case, some regulation will be essential because of the scarcity of frequencies and orbital "slots" for satellites.

The commission lost its first chance to deal with these questions when Comsat General Corp., the domestic arm of the government-created communications satellite firm (Comsat), revised its plans to file for FCC permission to run a DBS system jointly with Sears, Roebuck and Co. Comsat General had proposed the system last August. Although the talks between Comsat General and with Sears broke down in April, both companies have expressed continued interest in DBS.

WashingtonReport

Warning: Electrostatic-sensitive components

Many delicate semiconductor devices and ICs that are susceptible to damage from electrostatic potentials will be identified by a new symbol: a hand in a triangle with a bar through it. Packaging will bear the warning: "Attention—Observe precautions for handling electrostatic sensitive devices."

The label and warning message were developed by the Electronic Industries Association for industrywide use. EIA suggests that all devices sensitive to static discharges carry the warning "on the lowest practical level of packaging" and that the pictorial symbol be used, whenever possible, on the device itself. The label and warning message are available from EIA as engineering standard RS-471.

Air Force unveils an infrared sensor

A joint Air Force-private industry project has produced an infrared imaging camera that uses advanced IC technology and a completely new focal-plane sensor and signal processor combination. The new camera is smaller and lighter and will cost one-tenth the amount of current units, according to Pentagon officials.

Dr. Freeman Shepherd, chief of the Air Force Electronic Device Technology Branch (Hanscom AFB, MA), says that the camera employs principles adapted from designs for lightweight television cameras. The new technology is expected to spill into cameras for civilian use at a similar savings.

Personnel from the Air Force and RCA Corp. and scientists from Northeastern University cooperated on the project. RCA Laboratories in Camden and Princeton, NJ, have been awarded contracts to design surveillance systems based on the camera.

Missile intercepts arms agreement

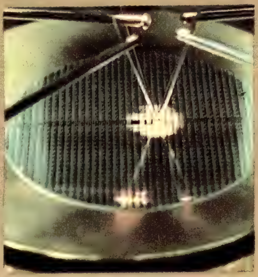
A highly advanced interceptor missile—that would violate a key 1972 arms agreement with the Soviet Union if deployed—is nearer to completion. Army officials reveal a major step forward in the program, the development of an electronic sensing system that allows the interceptors to distinguish between lethal warheads and debris from incoming ICBMs.

The missile is designed to protect land-based U.S. missiles from Soviet nuclear attacks. Major Gen. Grayson Tate, who heads up the program, said the antimissiles could knock out enemy ICBMs at an altitude of 100,000 feet as they near U.S. Minuteman, Titan and MX installations.

Capital Capsules

A California-based group has launched **a fund-raising drive to ensure that NASA keeps receiving and analyzing data** from the Viking lander on Mars. The San Francisco chapter of the American Astronautical Society has raised $8000 so far and hopes to get $1-million, which it will turn over to NASA.... **Another group of space buffs have formed a political action committee** called "Campaign for Space," to funnel campaign contributions to political candidates that express sympathy with the space program. The organization is headquartered in Washington.... **The FCC has denied two rulemaking petitions** that would have permitted the manufacture and sale of external linear amplifiers for portable radios operating in the 33 to 35-MHz band. Two Pennsylvania organizations filed the request on behalf of public emergency service radio users. The FCC bans linear amps that could be modified to boost CB radio signals and interfere with normal broadcasting.

Proven performance.

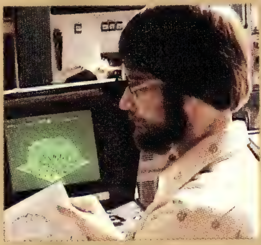


Semiconductor test systems are nothing new to Tektronix, we've been building them for years. Today, there's the S-3270 for device characterization, the S-3250 for production testing, and the S-3280, created to test high-speed ECL/LSI devices. Each has a 20 MHz clock rate.

Flexibility.

You can buy the system that meets your needs today, and add to it anytime. We'll work with your engineers to assure you aren't buying more or less than you need.

Easy to use.



Only one language to learn. All three systems use TEKTEST, a test-oriented language very close to English. Your test engineers will quickly generate, edit, and debug device-testing programs. And with the Computer Aided Program Generation option, they'll easily generate many test programs. All systems feature highly advanced data reduction and graphics, making test results manageable and easily understood.

Training.

We'll support your test engineers with a comprehensive training program and thorough documentation.

Worldwide support.

We're a phone call away.

To find out which S-3200 system and options best meet your needs, call in the U.S.: 503-645-6464. In Europe, Africa, Middle East: (The Netherlands) 020-471146. In Japan and Far East: (Tokyo) 03-448-4851.

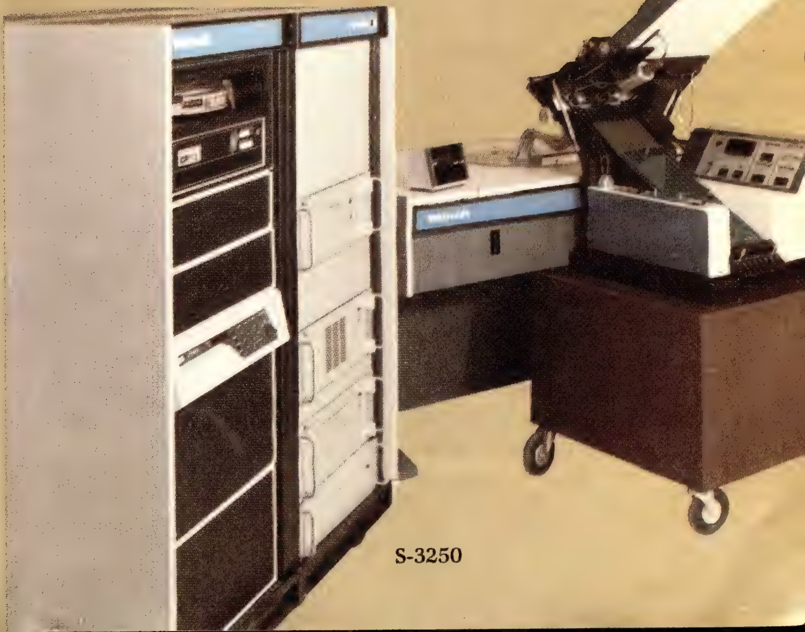
Tektronix®
COMMITTED TO EXCELLENCE

Choose the test system that fits your needs. Add more capability when you need it.

R & D and Characterization.

Production testing.

We make moving ahead easy.



S-3250

Copyright © 1980, Tektronix, Inc. All rights reserved. 849-1

The problem in big board testing is finding the problem.

Introducing the FF323. The first digital in-circuit test system that can test up to 2400 points and pinpoint the problem right down to the component.

Building faults into large, digital PC boards is inevitable. And the bigger the board the more chance of faults. Simple shorts, opens, misorientation and misinsertion faults cause most. But chip faults, such as stuck at one or zero, IC power loss or functional failure can all occur at final test. Until now, finding faults like these was like finding a needle in a haystack.

The new FF323 from Fairchild has changed all that. It's a digital in-circuit test system with 2400 points – more than twice the capacity of any other system. It not only tells you where the fault is, but what the fault is.

It can test a broad range of SSI, MSI and LSI device types, and it can isolate faults on highly complex PCBs. It can handle microprocessors, peripheral chips, bit slices, RAMs, ROMs, shift registers, UARTs, as well as the full range of small and medium scale ICs in technologies like CMOS, NMOS, SOS, TTL and DTL. The FF323 can even pinpoint the analog component problems on your digital boards.

You save time, labor, money and headaches.

The FF323's testing capability delivers complete and precise fault isolation in seconds – not hours. A 100 chip board can be tested in 100 seconds. And the FF323 delivers yields of 95% and better at final test. Fairchild's in-circuit testing strategy safely isolates catastrophic faults, before power-up (testing begins) so costly ICs won't be unnecessarily destroyed. And our patented digital testing technique insures comprehensive, functional interrogation of ICs.

You do more testing, less programming.

FF323 software helps you solve the problems of development costs and turnaround. You get up to speed quickly and stay there with the world's most comprehensive IC testing library. Our FAULTS automatic program generator gets new board testing programs on line in weeks instead of months. And the BASIC editor makes program changes problem free so you respond immediately to engineering changes.

Look closer, and you'll find our software short and simple. CHIPS, the LSI test compiler, allows fast test routine generation. Real time datalogging and analysis helps you keep track of component and board faults. And our foreground/background programming option gives you optimum CPU use with concurrent program execution.

Only Fairchild can offer all the big board testing you need.

FF323's flexibility lets you choose a system configuration to suit your application. Choose from either 1200 or 2400 system point capacity – just plug in 32 point switching modules as you need them. Our range of computer and peripheral options lets you select a well balanced data management subsystem. An instrumentation option is also available and Fairchild's Thinline® fixturing system lets you choose from a wide variety of fixtures, fixture kits and two universal designs.

With Fairchild, you'll also get all the applications engineering, training, service and support you need to keep testing without interruption.

For more information on the FF323, contact your nearest Fairchild Test Systems sales office. Or write Fairchild Test Systems Group, 299 Old Niskayuna Dr., Latham, N.Y. 12210. Tel. (518) 783-3600.

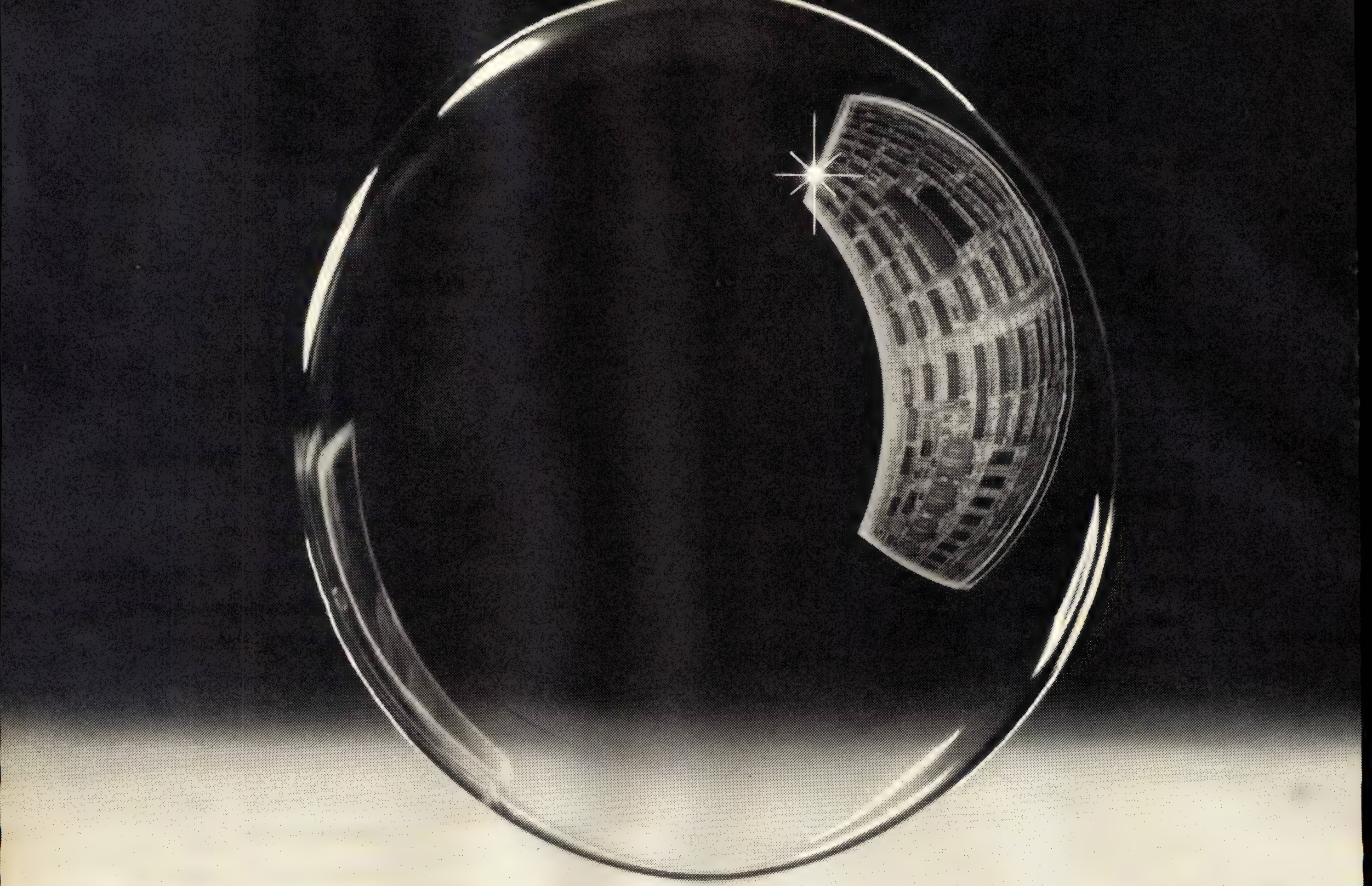
FAIRCHILD

A Schlumberger Company

The first family of ATE.

COME SEE THE FF323 AT ATE BOSTON, JUNE 16-18.

CIRCLE NO. 24



Plessey bubble memories

standard and custom-built

Now you can confidently incorporate magnetic bubble memories in your next product development: Plessey is fully equipped to design and produce to your spec. Or you can buy add-in bubble memory cards for your Intel SBC systems. Plessey has a range of compatible systems actually in production. Shouldn't you be talking to us now?

Here are some Plessey bubble memory pluses:

- Rugged, maintenance-free, non-volatile storage at a lower cost than CMOS + battery.
- More compact, more reliable and faster than disc or cassette.
- 64 k or 256 k byte Multibus* compatible cards.
- Software compatible.
- Low power requirement.

Reliable products from a specialist manufacturer with many years' experience of standard and custom-built memories—made from both magnetic and semiconductor devices.

Contact Plessey Microsystems sales office to discuss your needs for the future, or send for your copy of the Bubble Memory Systems literature folder.

PLESSEY
MICROSYSTEMS

Plessey Microsystems Limited, Water Lane, Towcester,
Northants NN12 7JN.
Telephone: Towcester (0327) 50312. Telex: 31628.

Plessey Microsystems Inc, 19546 Clubhouse Road,
Gaithersburg, Maryland 20760.
Telephone: (301) 948 2791. TWX: 710 828 9708
and at 1641 Kaiser Avenue, Irvine, California 92714.
TWX: 910 595 1930.

*Intel trademark.

CIRCLE NO. 167

0654 2 0124

ElectronicDesign

INTERNATIONAL

May 10, 1980

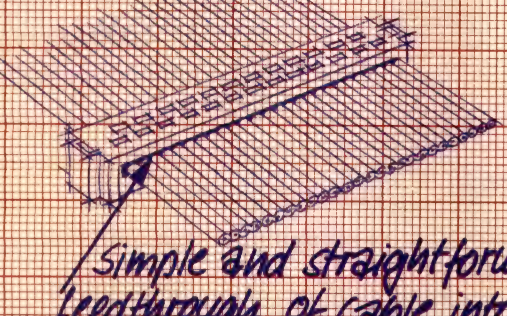
Analyzer combines three digital testers in one

Dual-disk system develops 8080A, 8085A products

Synthesized signal generator uses low-noise oscillator

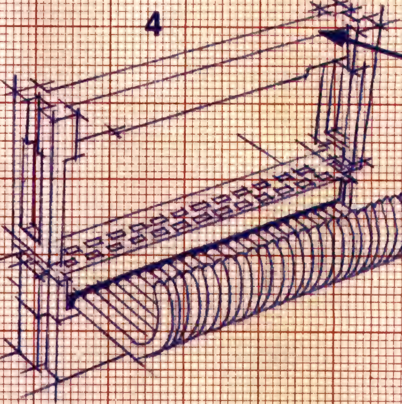
F 303: a mass of concepts... designed

1



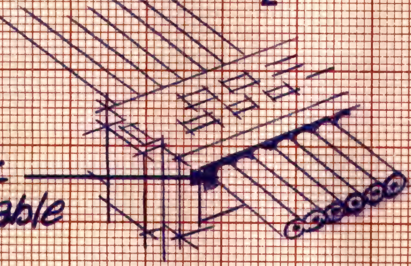
Simple and straightforward feedthrough of cable into pressure block

4



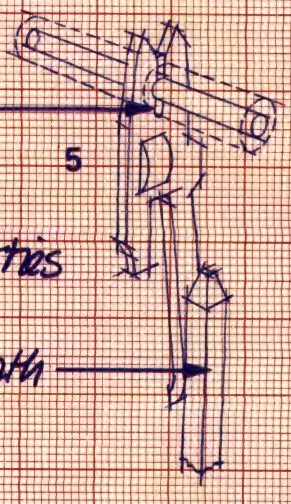
Optional strain relief bridge

2



Profiled pressure block matches cable

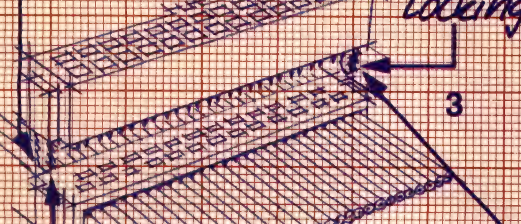
5



Beryllium copper contacts: optimum piercing and better relaxation properties

Long wiping contact path

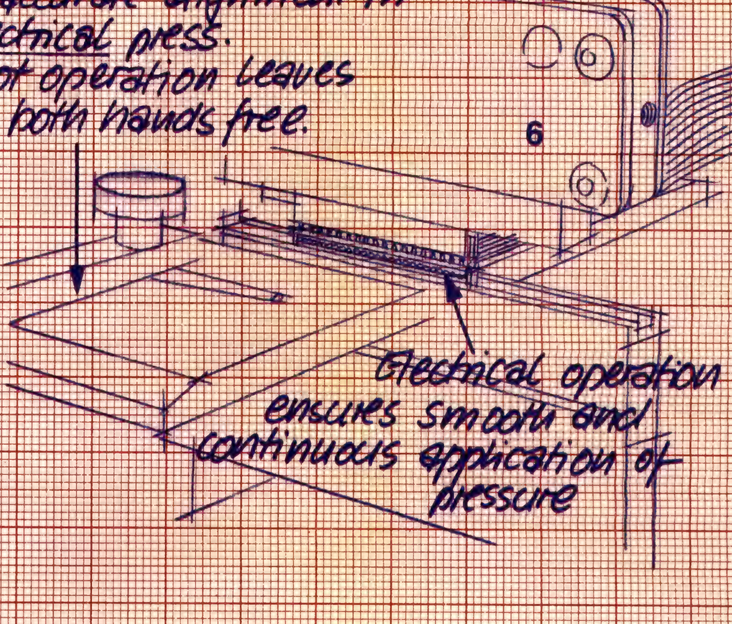
3



Barbs provide progressive step-by-step locking

Contact block features firtree-shaped barbs. these enable the two blocks to be pre-mounted

6



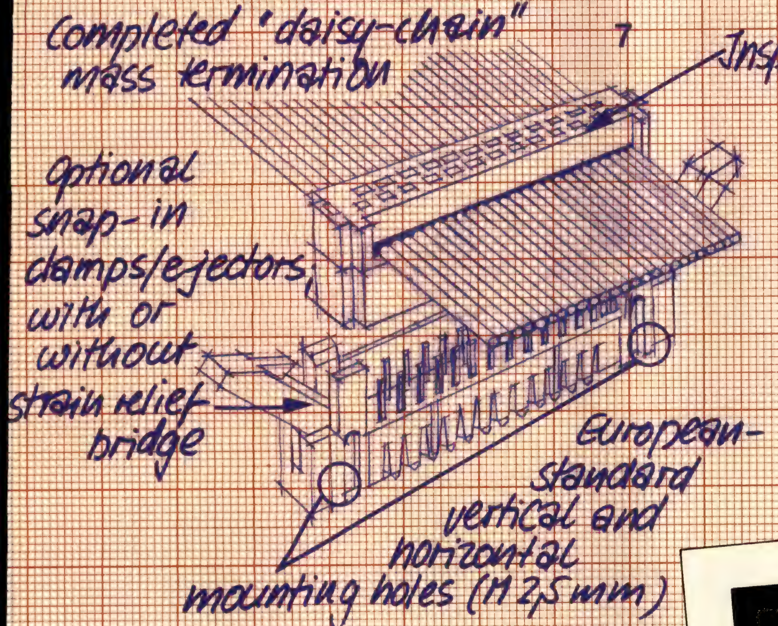
Guides facilitate accurate alignment in electrical press. Foot operation leaves both hands free.

Electrical operation ensures smooth and continuous application of pressure

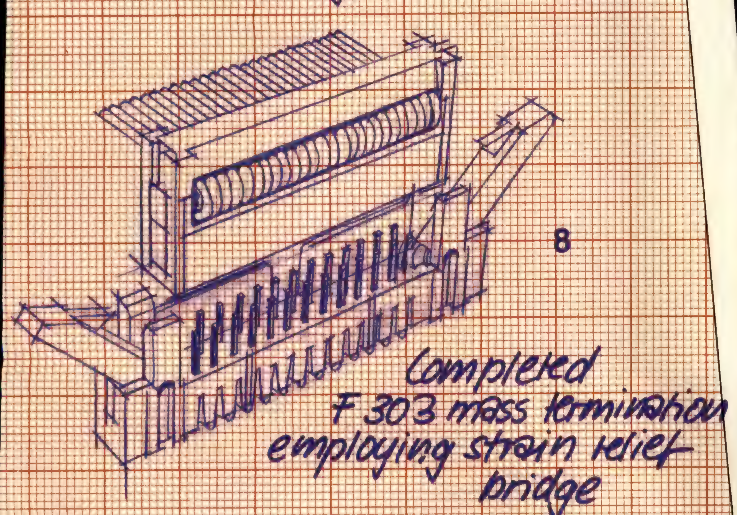
PHILIPS

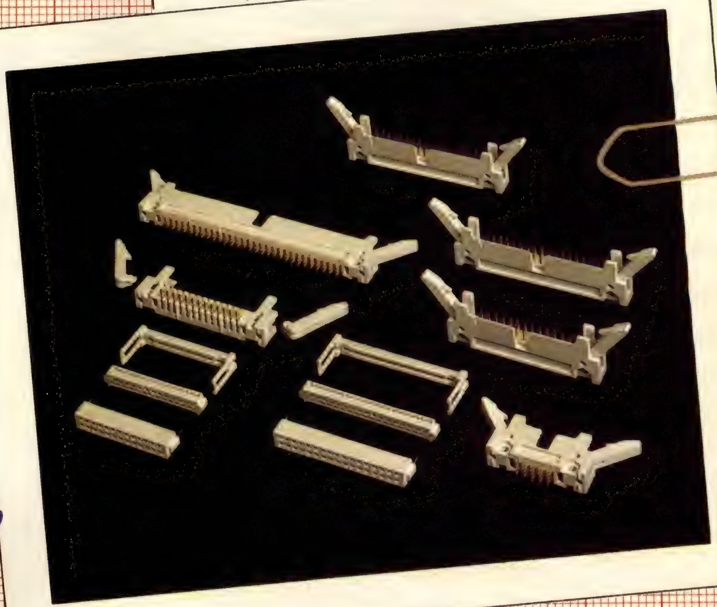
Electronic
Components
and Materials

good termination and made in Europe


Completed "daisy-chain" mass termination
7
Inspection holes
optional snap-in clamps/ejectors with or without strain relief bridge
European-standard vertical and horizontal mounting holes (M 2,5 mm)

F303	Feature Check List	Yes	No
1.	Cable feedthrough	✓	
2.	Profiled pressure block	✓	
3.	Easy aligned contact block	✓	
4.	Strain relief bridge	✓	
5.	Beryllium copper contacts	✓	
6.	Electrical press	✓	
7.	European design	✓	
8.	Flexible clamp/ejector fitting	✓	


8
Completed F 303 mass termination employing strain relief bridge



All these excellent design concepts come together in the new F 303 mass termination system. Many are unique and they add up to unmatched interconnection versatility. For example, only the F303 offers you hands-free alignment via the electrical press. And only the F303 is designed and made in Europe to European standards.

Make a list and check out our claims. But to do that you'll need the F303 brochure. It's yours if you check the reader service number below.

Philips Industries, Electronic
Components and Materials Division,
Eindhoven, The Netherlands.

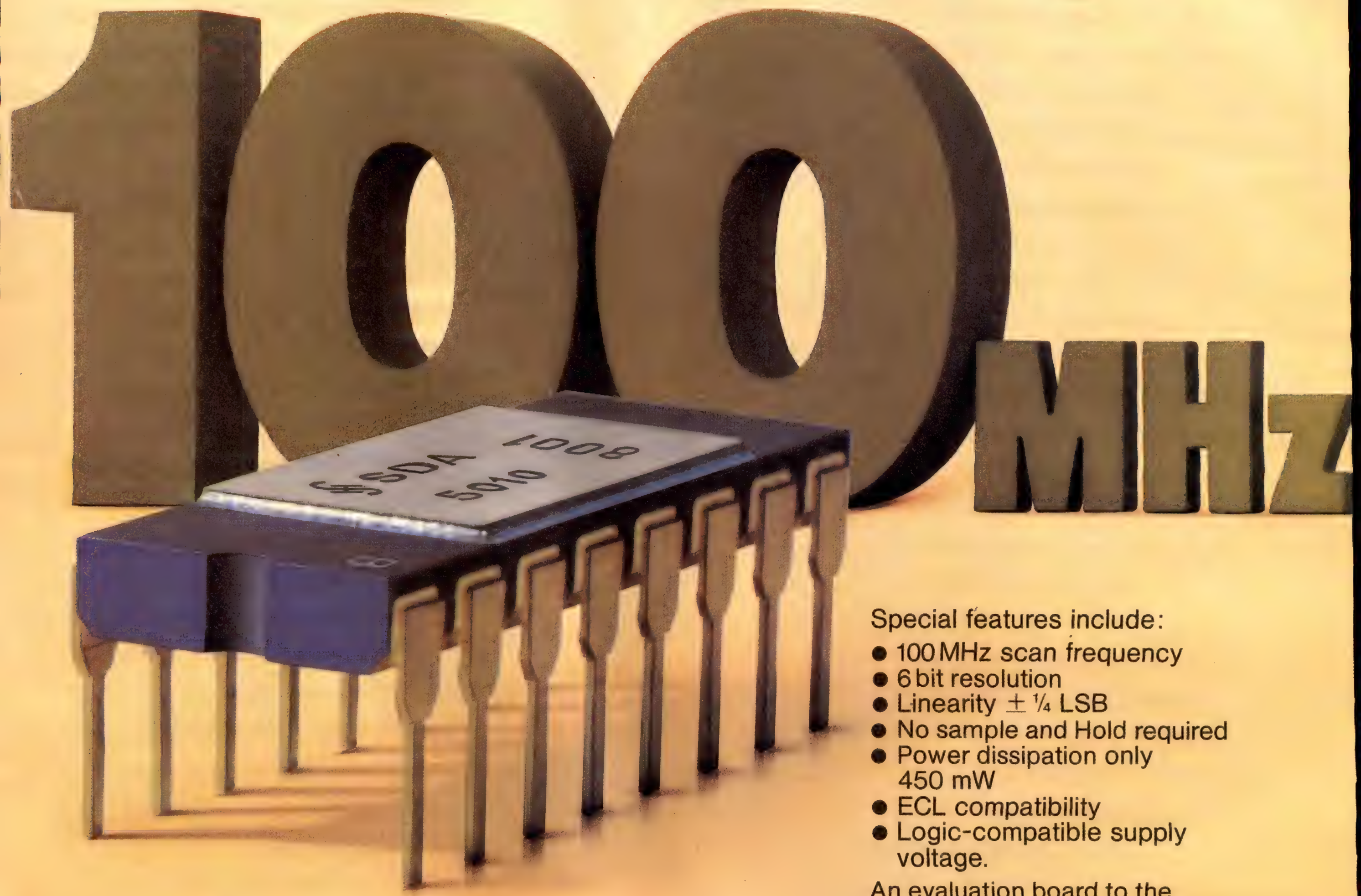
We'll keep you well connected

PHILIPS

CIRCLE NO. 233

SIEMENS

In Ten Nanoseconds from Analog to Digital



Special features include:

- 100 MHz scan frequency
- 6 bit resolution
- Linearity ± ¼ LSB
- No sample and Hold required
- Power dissipation only 450 mW
- ECL compatibility
- Logic-compatible supply voltage.

An evaluation board to the SDA 5010 is, of course, available.

In only 10 billionths of a second it converts analog signals into digital 6-bit words. This is the new extraordinary device from Siemens – the SDA 5010.

It's the first 6 bit/100 MHz A/D converter in bipolar, monolithic technology, it's reasonably priced, and its applications range from radar, ultrasonics and instrumentation to X-ray and medical engineering.

And that's only half of it. This device has many other technical refinements. Find out about them from Siemens AG, Components Group, ZVW 104, Postfach 103, D-8000 Munich, quoting "Integrated A/D Converter".

B 8008.101

The ultrafast, integrated A/D converter from Siemens

new '80

CIRCLE NO. 238

InternationalProducts

Analyzer combines three digital data testers in one

The Sony/Tektronix 308 data analyzer combines the functions of three separate digital-test instruments in one portable unit. The analyzer performs state and timing analysis of parallel signals, state analysis of serial data and signature analysis on some digital products.

The Model 308 has two memories. The display memory stores up to 252 bits on each of eight channels for subsequent display on a screen. The reference memory compares two separate sets of data and identifies differences between them. The reference memory also provides an automatic restart that is useful when the operator is looking for intermittent failures—a so-called "babysitting" mode.

The analyzer records on as many as eight channels simultaneously, to capture information on multiple lines. It acquires parallel data either synchronously or asynchronously, and examines the data at sample rates up to 20 MHz. A "latch" mode captures pulses as short as 5 ns. Data setup takes 25 ns. Threshold voltage is variable from −12 to +12V. A switch that sets up TTL thresholds is also provided.

Tektronix U.K. Ltd., Beaverton House, P.O. Box 69, Harpenden, Hertfordshire, England. Harpenden 63141. Telex: 25559.

CIRCLE NO. 501

Dual-disk system develops 8080A, 8085A products

The MMD-DDS microcomputer development system from Vector International should prove a versatile tool for designing products based on 8080A and 8085A microprocessors. The dual-disk system packs an MMD microcomputer Eurocard set, a power supply and drives into a portable, 19-in. Eurorack. Software support includes a disk operating system, file management, a debug monitor, a macroassembler, a linking loader and a text editor. A 2716 EPROM programmer is standard.

The debug monitor, file-management program, and disk operating system are EPROM-based, which makes the 24 kbytes of RAM provided with the basic system completely available for user programs and for the diskette-based macroassembler, text editor and linking loader. In addition, the RAM is expandable to 48 kbytes, to accommodate high-level-language options.

The disk operating system and a monitor reside in EPROM. Various high-level language options are available.

Vector International, Research Park, B-3030 Leuven, Belgium. (016) 20.24.96. Telex: 26202 vector.

CIRCLE NO. 502

The hot new the good old

PM3500 100MHz 16 Channel Logic Analyzer

PM3212 25MHz Dual Trace Scope

PM3226 15MHz Dual Trace Scope

PM3243 50MHz Multiplier/Storage Scope

PM3263 100MHz
Microprocessor-Equipped Scope

PM3266 100MHz Storage Scope

PM3218 35MHz Delayed Time Base Scope

PM3540 10MHz Logic State Analyzer

PM3214 25MHz Delayed Time Base Scope

You can't buy a faster 100MHz logic analyzer than our PM3500. You can't buy a more tested and proven 25MHz delayed time base scope than ours. And between those two there's a full line of superlative scopes from Philips.

We've been around long enough to know how to build better scopes. Our first one came off the line in 1936. And with its introduction began our concept of human-engineering—utilizing logical design and control placement to speed both learning and using.

Over the years we've made a lot of scopes—and more electronic gear in more fields than you could imagine.

When there's a better, more innovative way to design new scopes or update older scopes, we'll do it. But we do much more. We can offer you an advanced Microcomputer Design System and a vast range of digital and analog multimeters, chart recorders, LF and RF oscillators, microwave equipment, DC power supplies, frequency counters, pulse generators and TV studio and transmission equipment.

For more information contact the Philips organisation in your country or write to Philips Industries, Test & Measuring Instruments, TQ III-2, 5600 MD Eindhoven, The Netherlands.

scopes and standbys.

PM3225 15MHz
Single Trace Scope

PM3207 15MHz/5mV. Dual Trace Scope

PM3216 35MHz Single Time Base Scope

PM3262 100MHz Dual Trace
Universal Scope

PM3244 50MHz 4-Trace Scope

PM3265 150MHz Scope with 100MHz
Analog Multiplier

PM3211 15MHz Dual Trace Scope

PM3234 10MHz Dual Beam Storage Scope

PM3233 10MHz Dual Beam Scope

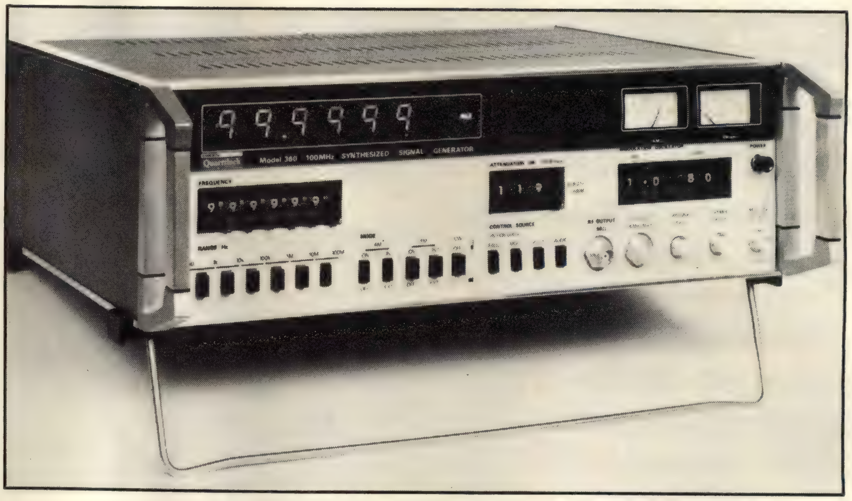
From Philips, of course.

PHILIPS **Test & Measuring Instruments**

PHILIPS

CIRCLE NO. 232

Synthesized signal generator delivers low-noise output



A synthesized, 100-Hz to 100-MHz, signal generator, the Model 360, depends on a high-Q, varactor-tuned oscillator for optimum low-noise performance. Because the instrument is fully programmable through the IEEE-488 bus, unskilled operators can use it for production and development applications.

Frequency is controlled by digital lever switches and push-buttons, reducing operator errors and eliminating analog uncertainty. The frequency switches in less than 350 ms and typically within 250 ms. Harmonics are kept more than 40 dB down for frequencies above 10 MHz. Spurious suppression is at least 70 dB, and typically 80 dB; phase noise is typically less than −125 dB.

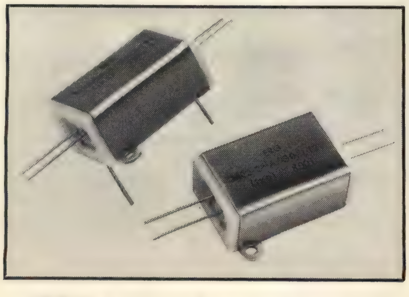
Because of its size (132 × 432 × 368 mm) and weight (13 kg), the Model 360 transports easily to remote test sites. The case keeps rf leakage low enough to meet and satisfy military environmental specifications and safety standards. BCD signals at TTL levels offer remote control of the frequency and level of the output and of the modulation mode, rate, depth and deviation.

The maximum output amplitude of the 360 is 1 V rms into a 50-Ω load. Accuracy is maintained at ±0.15 dB at 1 MHz; flatness, at ±0.5 dB. Attenuator range is 0 to 119 dB in 1-dB steps. The unit's power requirement is 235 or 117 V ac at 50 or 60 Hz, ±10%. Full specifications are maintained from 0 to 35 C.

Quartzlock LTD., Newnham Industrial Estate, Plymouth PL7 4LU, South Devon, England. (0752) 333300.

CIRCLE NO. 503

Reed relay offers high circuit isolation



MO2 reed relays maintain a high insulation resistance of 10^{14} Ω between isolated circuits. The parts are designed for work in low-leakage circuits. Single or double Form A contacts are offered although other inserts can be ordered. The relay switches 10 W resistive. Reed-to-coil dielectric strength is approximately 500 V rms while switching time, without coil lag, is typically 0.7 ms. Standard coils from 5 to 24 V dc are available. Magnetic screening is provided and electrostatic screens are available as an option. Working temperature range extends from −55 to +100 C. The relays measure 28.57 × 25.4 × 12.7 mm, including fixing holes.

Erg Components, Luton Rd., Dunstable, Beds LU5 4LJ, England. 0582-62241. Telex: 82349.

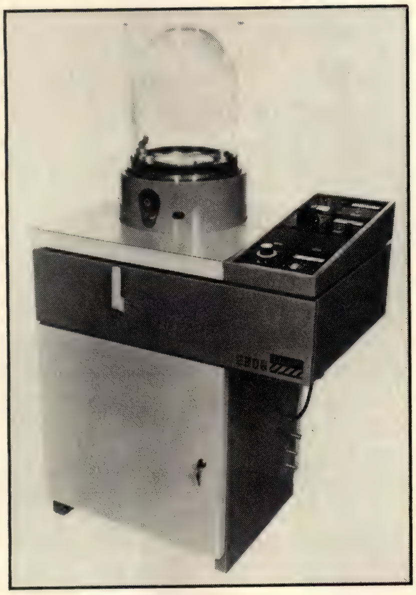
CIRCLE NO. 505

Recorder gets transient on cassette and RAM

A microprocessor-based, two-channel transient recorder, the DL1080, digitizes and stores waveforms, at sample rates of up to 20 MHz per channel, in each of two, static, 4-k × 8-bit RAMs. An integral minicassette unit provides backup store. A waveform acquisition and measurement instrument, the DL1080 handles one shot and low-repetition events. Selection of recording parameters, such as sweep time, trigger levels and input sensitivity, are achieved by means of a single control knob. This facility gives the instrument an "analog feel," considered by some to be superior to a "keyboard-only" approach. Six recording modes are available, including delayed sweep, dual-speed timebase and a new mode which allows one channel to "zoom in," at a high sample rate, on an interesting region of the other channel. Two EAROMs are provided to store two complete sets of front-panel settings.

Data Laboratories Ltd., 28 Wates Way, Surrey, CR4 4HR, England. 01-640 5321. Telex: 947680. **CIRCLE NO. 506**

Direct-drive pump helps vacuum coater



A direct-drive, two-stage vacuum pump improves the performance of the E306A vacuum coater. The unit assists such general-purpose coating techniques as carbon evaporation, dc and rf sputtering, electron-beam source heating, ion plating and glow discharge cleaning.

Edwards High Vacuum, Manor Royal, Crawley, West Sussex RH10 2LW, England. 0293 28844. **CIRCLE NO. 507**

Machine controller parallel processes I/O

A single-board module, Flash 8-256, provides flexible programming control of automatic machinery for sequences of up to 256 steps. Key to its operation is parallel processing of input and output data. This gives the fast response needed for on-line control of high-speed machinery. Programs are entered by direct access into 2-k of RAM and can be developed either on or off line. Only a single instruction is required for each sequence step. Each instruction relates directly with one physical operation of the machine or process under control. Programs developed in RAM can be replaced by programs stored in permanent PROM after on-line proving. The 8-256 operates from 24 V dc and provides continuous LED monitoring of input and output data. The board exhibits a high, intrinsic noise immunity.

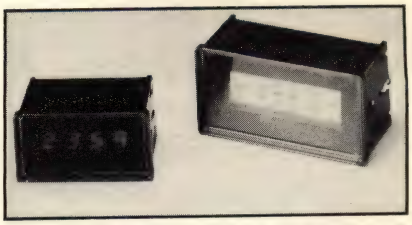
Payling Electronics & Control Ltd., 131 Folds Lane, Sheffield S8 OET, England. 0742 26622. Telex: 24554 Jaston G. **CIRCLE NO. 508**

Monitor/module team for color data display

A compact, sturdy color monitor, CM 33, works with an optional RGB module to display data for any industrial or house computer system. The unit can be rack-mounted for use in any fixed or mobile application. An optional screen shade allows viewing even in high-intensity light conditions. The shade folds to protect the monitor's screen during transport. Power supply requirement is 110 or 220 V, 40 to 60 Hz. A 12-V adapter is available. An isolated switching-mode power supply prevents mains interference to the monitor's picture. The monitor measures 266 × 405 × 386 mm and weighs 14 kg.

Barco Electronic N.V., Noordlaan 5, 8720 Kuurne, Belgium. 56/35.14.11. Telex: 85.305 barco b. **CIRCLE NO. 509**

Modular bezel eases LED/LCD mounting



A modular bezel, designed around DIN 43700 specifications, facilitates LED/LCD or motherboard mounting. The bezel is held in position on a front panel by integral securing clips. The bezel can be removed from its mounting as a complete unit. Two sizes are offered—72 × 36 mm and 96 × 48 mm. Both bezels are 45-mm deep. Special sizes to a customer's specifications can be manufactured in production quantities.

Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hampshire 505 3ZR, England. (04215) 69911. **CIRCLE NO. 510**

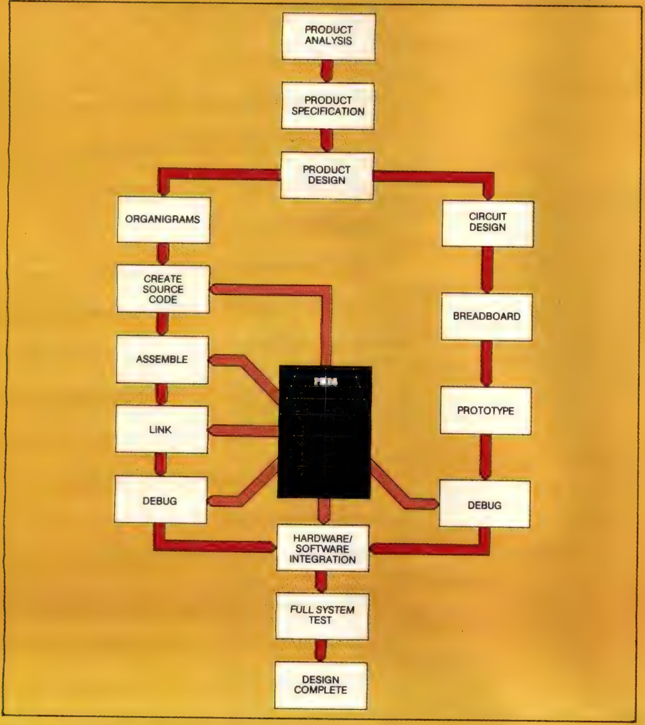
Metric servomotors come ready for long life

A range of metric-sized dc servomotors are equipped with durable parts for long-life service. Five frame sizes are offered, from 27 to 80 mm. Copper-graphite brushes and core-plated, silicone-steel armature laminations are built for maintenance free service. Diamond turning of the molded, silver-bearing, copper commutators after armature assembly assures optimum concentricity and finish. Precision mounting spigots on the front and rear end frames allow accurate mounting and alignment and permit attachment of encoders and pulse generators.

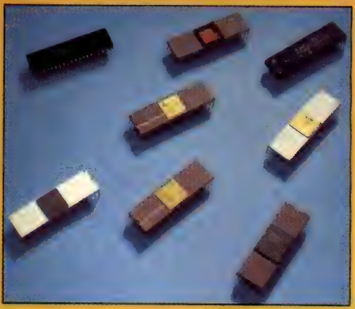
Moore Reed and Company Ltd., Walworth Industrial Estate, Andover, Hampshire, England. Andover (0264) 4155. Telex: 47654. **CIRCLE NO. 511**

Microcomputer imple
the direct route
Philips Microcomputer Develop

In the development of new microcomputer applications, the Philips MDS - Microcomputer Development System - can help you take the direct route to successful, economic system implementation. By shortening your development lead-time, PMDS helps you maintain your competitive edge. And by greatly reducing the man-hour input needed to realize your system, it helps you minimize your overall development costs. Another important cost-cutting factor is the easy-to-learn, interactive PMDS software providing full operator guidance and eliminating start-up delay.



True system emulation
Using PMDS, your hardware and software engineers can work closely together throughout each development phase. Testing and debugging can be carried out even before prototype hardware is available, thanks to PMDS' true real-time system emulation capability. Your complete system - hardware and software - can be exercised under actual operating conditions before you make any production commitments. As a result, integration of hardware and software into your final system is quick and problem-free, because both elements are designed and tested together right from the start.



The universal system
PMDS has the essential flexibility to take technological advances in its stride. If you want to take advantage of new microcomputer developments, or if your next project calls for a different chip, PMDS leaves the choice open. Because PMDS was designed as a universal system, it can simply and economically be adapted by a range of Microcomputer Adaptor Boxes (MABs) for all the most important microcomputer systems. So you won't be committed to any single supplier who may not have the new technology you need, or who can't give you the right price/supply conditions.

Philips - your system partner
As Europe's leading manufacturer of electronic instrumentation of all kinds - both analogue and digital - we have extensive experience of all aspects of product testing and development. In addition, we are both a major manufacturer and user of microprocessor and microcomputer products. So we know the problems that arise in developing these systems, and how best to approach and solve them. With PMDS, you can benefit from our experience in applying computer technology to microcomputer development.

For further information about PMDS, contact

Philips Industries, Test and
Measuring Instruments Dept.,
TQ III-2-51, Eindhoven,
The Netherlands.

PHILIPS **Test & Measuring Instruments**

mentation -

ment System

From Philips, of course

PHILIPS

CIRCLE NO. 235

AGFA-GEVAERT

We do not only supply you with film you are getting dimensional stability into the bargain!

A polyester base that got a specia treatment... An extremely thin low gel emulsion...
The two together give Copyline HD and HDU film this extreme dimensional stability.
Films that under all circumstances ensure outstanding quality (as we as line sharpness, contrast, capability of being written on, retouchability, etc.).
Our technician will be glad to show you the numerous possibilities. Also in automatic processing, in Copyline AP 126, Rapimat 65 or in a lith processor, dimensional stability will be ensured.

And this is important, particularly in electronics. When making printed circuits, by way of example. As average always some 10 to 12 superposed layers: extremely small and needing scrupulous care.

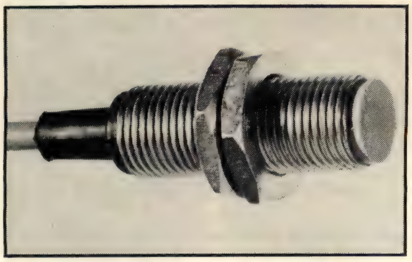
You start out from drawings (no problems when making them on Copyline drawing film). Then you work by means of photographic techniques, reduced, duplicated on Copyline HD or HDU film.
You will highly appreciate the dimensional stability. For all these films have to fit exactly on each other, without any register differences.
Copyline in electronics: the pat answer!

AGFA-GEVAERT N.V.,
B-2510 Mortsel-Belgium

CIRCLE NO. 236

Agfa-Gevaert: your go-ahead partner!

Proximity detector spots nearby metal parts



Two-wire, inductive proximity detectors, ISH 2 and ISH 5, sense the presence of metal parts as they pass close to the probes' sensitive areas. The devices are suitable for use as limit switches or high-speed counting units. The detectors react with all metals, but are most effective when used with ferrous materials. They can be directly interfaced with many types of electronic equipment. When direct load switching is required, relay amplifiers with internal power supplies are available. The ISH 2 version senses at a nominal distance of 2 mm while the ISH 5 detects at 5 mm. Output current, at 12 V dc, drops from greater than 3 mA to less than 1 mA when metal is present. The sensors come in 5/8-in. diameter threaded bodies and are offered with an integral cable or termination tags.

Control Ability Ltd., Cambridge Street Works, Cambridge Street, Great Harwood, Blackburn, Lancs. BB6 7BU, England. Blackburn (0254) 886685.

CIRCLE NO. 512

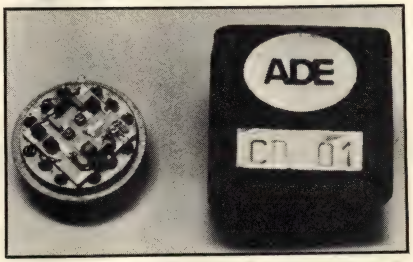
Bug-eye lens increases photodiode sensitivity

A planar, silicon photodiode, BPX-65, uses a bug-eye lens to focus collimated light onto its active area and thus increase its sensitivity. Peak sensitivity is at 850 nm. Dark current is typically 1 nA at a reverse bias of 20 V; the cut-off frequency is 500 MHz at this bias. The active area measures 1 mm^2. Photosensitivity to light from a black-body source at 2856 K is 6 $nA\text{-}Lux^{-1}$. The device operates between the temperature extremes of -55 to $+125$ C. Due to its good high-frequency response, the photodiode is capable of detecting wide-bandwidth signals.

Centronic, Centronic House, King Henry's Dr., New Addington, Croydon CR9 OBG, England. Lodge Hill (0689) 42121/8. Telex: 896474 Centro G.

CIRCLE NO. 513

Rf hybrid amp gives high gain in small space



A series of rf integrated amplifiers, Type CS01, offer a gain of 20 dB over a bandwidth of 5 to 400 MHz. Despite the high gain, the units have a noise figure of only 4 dB and an overall flatness of ±1 dB. Amplifier output is +13 dBm, while VSWR is only 2:1. The units require a single 15-V supply. CS01 devices use an alumina substrate. Lower cost versions use standard encapsulation and an epoxy-glass support. CD01 and CD02 types have lower gain but at a cost savings.

Nore Microwave Ltd., 36 Towerfield Rd., Southend-on-Sea, Essex, SS3 9QT, England. 03708 4255:6.

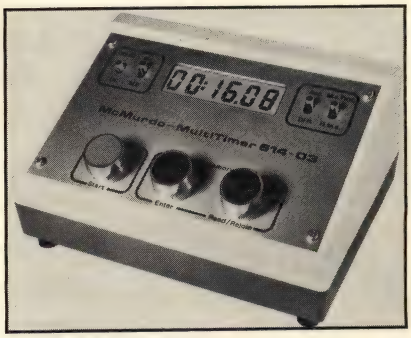
CIRCLE NO. 514

SMA receptacles give choice of contacts

Two flange-mounted SMA receptacles give the user a choice between removable or captivated contacts for use up to 18 GHz. Part number 50-645-4518 is a narrow-flanged jack receptacle with flush dielectric and a removable contact with tab termination. Part number 50-645-4528 is identical, expect that the contact is captivated during assembly. Both connectors are manufactured from stainless steel with a gold-plated or passivated finish. Female contacts are beryllium-copper with a gold-plated finish. The mounting flange is 0.223-in. wide and 0.625-in. long. Fixing screw holes are 0.102-in. in diameter.

Sealectro Ltd., Walton Rd., Farlington, Portsmouth, Hampshire, England. Cosham 73211. Telex: 86142. **CIRCLE NO. 515**

Timing unit uses memory facility

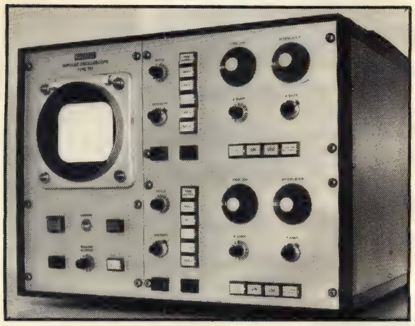


A portable timing device, Multitimer 614, uses a memory system to permit timing and recording of a number of events at very close intervals. Time measurements can be carried out to a resolution of 1/100 s with 99.999% accuracy over a time range of up to 100 h. In addition, the unit can be set for real time operation over a 24-h cycle. All time measurements are displayed on a six-digit, 12.5-cm LCD readout. Standard batteries provide in excess of 200 h operation. A jack permits operation from an external 9 to 12-V dc supply.

McMurdo, Rodney Rd., Portsmouth PO4 8SG, England. Portsmouth 735361.

CIRCLE NO. 516

Impulse scopes operate in strong EMI fields



Type 711 and 721 impulse oscilloscopes record single transient voltage or current impulses in an environment of strong electromagnetic interference. The units fulfill the most recent requirements of IEC Committee No. 42 with respect to electromagnetic compatibility. Type 711, a single-beam scope, and type 721, a double-beam unit, use a special CRT with high writing speed and a direct measuring input (without an intermediate amplifier). An automatic recording system provides a record of the most important test-related data: time-base deflection, attenuator adjustment, photograph number, calibration lines and time marks. A digital display, in conjunction with the Type 64M impulse peak voltmeter, indicates the measured peak value in kilovolts directly in the oscillogram. Both scopes are designed as portable instruments. Photographic accessories are offered.

Emile Haefely & Co. Ltd., High Voltage Test Systems, Lehenmattstr. 353, Postfach CH-4028, Basel, Switzerland. 061-41 18 17. Telex: 62 469 **CIRCLE NO. 517**

Gas display shows 0.5-in. characters

An alphanumeric gas-discharge display, SP-450-018, presents twenty 0.5-in. characters for viewing distances of up to 40 ft. Designed for multiplexed operation, the display uses a 14-segment format to provide numerals, an upper-case alphabet and many special characters and symbols. The flat-screened image of neon-orange characters has a 120° viewing angle and a brightness of 70 ftL. The display has a 0.8-in. mounting depth, including tubulation, and measures 1.6 × 10.5 in.

Beckman Instruments Ltd., Queensway, Glenrothes, Fife, Scotland KY7 5PU.

CIRCLE NO. 518

Controller directs up to 256 inputs/outputs

A programmable controller, PLC-256, handles up to a total of 256 inputs/outputs for direction of process and production steps. A main unit combines a control section with memory, a test unit and a power supply. Any combination of input and output units can be added, up to a total of 256 functions. Each module handles 16 functions. The input unit accepts signals from limit switches, pushbuttons, etc. and converts them for processing by the control unit. The output units, under instruction from the control unit, drive plant output devices, such as solenoids, contactors and lamps. Units of the PLC-256 are interconnected with ribbon cables. Other modules are plugged-in as required. The complete system mounts on horizontal DIN rails in a range of industrial enclosures.

Thorn Automation Ltd., P.O. Box 4, Rugeley, Staffs, WS15 1DR, England. Rugeley 5151.

CIRCLE NO. 519

Triple-output supply uses adjustable tracking

A power supply for IC and microprocessor applications, the Model 6TD20, combines a single 0 to 6-V output, rated at 5 A, with two 0 to ±20-V tracking outputs, rated at 1 A each. The tracking ratio of the dual outputs can be varied, setting the negative output to a voltage lower than that of the positive output in a range of 1:1 to 0.25:1. All outputs feature constant current-limiting circuits. No derating is required up to an ambient temperature of 50 C. The 6-V output is protected against overvoltages by a crowbar circuit. Voltage and current outputs are monitored by two panel meters. A flashing red LED indicates an overload condition on any of the outputs. Ten-turn controls permit high resolution.

Elind, Via Torino, 30, 20063 Cernusco S/N, Milan, Italy. (02) 9.041.319. Telex: 331113.

CIRCLE NO. 520

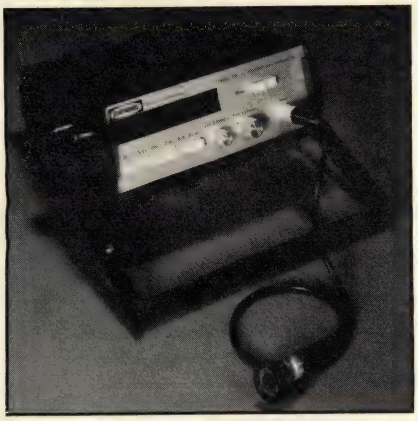
LCR bridge tests parts at the push of a button

A microprocessor-based LCR bridge, the Wayne Kerr B.605, automatically and quickly checks component values with few time-consuming adjustments. Automatic trimming and range finding eliminate control procedures while a microcomputer-guided display prompts the user. Two measurement can be made in 1 s with a 0.1% accuracy across a wide impedance range. An LCD readout offers five-digit resolution. Measurements are expressed directly in the most practical units selected from 12 possibilities. The units appear alongside the digits. Measurement range for resistors is 0.1 mΩ to 1000 MΩ; for capacitors, 0.001 pF to 1 F; for inductors, 0.001 μH to 10 kH. For batch testing, the instrument automatically selects the correct range for the first part and maintains the same setting. The instrument instructs the operator to press a range button if the change improves resolution.

Wilmot Breeden Electronics Ltd., Durban Rd., Bognor Regis, Sussex P022 9RL, England. 024 33 25811. Telex: 86120.

CIRCLE NO. 521

Photometer gathers light measurements

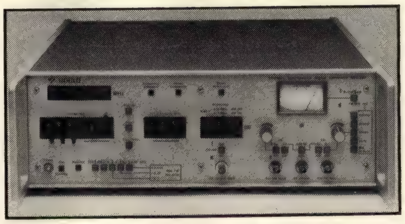


A benchtop photometer/radiometer, the Model 210, makes fast accurate readings for use in data acquisition systems or conventional testing. Direct readings in all the standard photometric and radiometric units can be made and displayed as a 3-1/2 digit decimal, with a single-digit signed exponent. Readings can be scaled by powers of ten. The instrument is sensitive to 10^{-12} W, 10^{-5} Lux and 10^{-13} A. Operation can be manual and autoranging over eight decades of power readings and manual ranging over four energy decades. This allows measurement of both continuous and pulsed sources. An analog output can be used with a chart recorder. An optional output provides information for data processing.

Centronic, Centronic House, King Henry's Dr., New Addington, Croydon, CR9 OBG, England. Lodge Hill (0689) 42121/8. Telex: 896474 Centro G.

CIRCLE NO. 522

Synthesized generator operates to 200 MHz

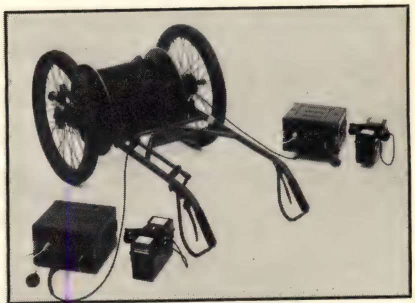


A synthesized signal generator, the Model SSG220, operates at frequencies from 10 kHz to 200 MHz in five ranges and with resolutions from 0.1 to 100 Hz. Stability and accuracy are maintained by an internal, oven-controlled crystal oscillator with a phase-locked loop (PLL) synthesis system. Facilities are provided for use of an external frequency standard. Maximum output is 1 V rms into a 50-Ω load. Up to 119 dB of attenuation can be switched in 1-dB steps to provide levels down to 1.1 μV. Linear, low-distortion amplitude, frequency and phase-modulation are available internally or externally. The set frequency can be stepped up or down by a preset amount, from 0.1 Hz to 100 kHz. Frequency selection and stepping are commanded by pushbutton and digital level switches. The resultant frequency is displayed on a 7-digit LED array. IEEE-488 or parallel input options allow integration of the SSG220 into automatic test systems.

Gould Instruments, Roebuck Rd., Hainault, Essex 1G6 3UE, England. 01-500 1000. Telex: 263785.

CIRCLE NO. 523

Field cable comes with LED and detector



A long-distance fiber-optic field cable comes complete with LED emitter and p-i-n diode detector. The cable is intended for the rigors of military use and incorporates two, plastic-covered glass fibers in a polyester film, surrounded by a cold-resistant PVC jacket. Connectors at either end of the cable incorporate the emitter and detector. The connectors merely establish electrical contact with associated terminal equipment. The optical cable is immune to EMI and can be laid along high-voltage lines, in the vicinity of transformer stations or along electrified railway routes. Up to 1600 m of cable, which has a diameter of 5 mm, can be accommodated on a normal drum. The transmission system handles digital signal rates of 256 kbits/s.

Standard Elektrik Lorenz AG, Hellmuth-Hirth-Strasse 42, 7000 Stuttgart 40 (Zuffenhausen), Federal Republic of Germany. (07 11) 821-2327. Telex: 7211.

CIRCLE NO. 524

Choose any of these multilayer ceramic parts and we promise immediate despatch.

	CAPACITANCE (µF)							
Range	'Skycap' Dipped Radial					Moulded Axial		'DIPGuard' Dual-in-Line
STYLE	SR15	SR20	SR21	SR30	SR40	MA10	MA20	MDO1
X7R 50V (Suitable for 63V) ±20% Tol.	0.001 0.01	0.022 0.047 0.1	0.022 0.047 0.1	0.22 0.33 0.47	1.0	0.001 0.01	0.022 0.047	0.001 0.01 0.022 0.047 0.1
Z5U 50V (Suitable for 63V) −20+80% Tol.	0.01	0.022 0.047 0.1	0.022 0.047 0.1 0.22	0.33 0.47 1.0		0.01 0.022 0.047	0.1	0.01 0.022 0.047 0.1

Decoupling

Good news if you use decoupling capacitors in microprocessor, memory and other electronic circuit designs. Now you can get more than 40 of the most popular multilayer ceramic types despatched to you immediately on receipt of your order.

Just think what that means for you.

We call this service AVX EXPRESS. We back it with millions of capacitors in stock; with a new European factory; and with a network of AVX offices, agents and distributors throughout Europe to ensure this immediate despatch service.

Your nearest AVX address will send you a copy of our decoupling catalogue packed with specifications, applications data and details of the AVX Express Service – immediately, of course.

AVX
IN EUROPE

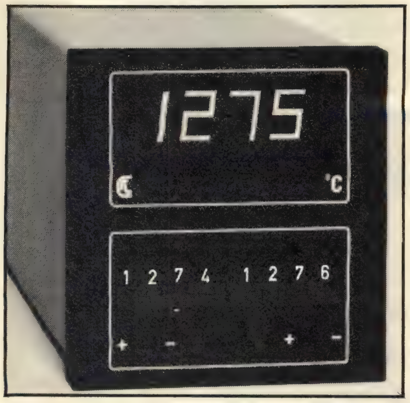
AVX Limited, AVX House, Manor Park, Aldershot, Hants. GU12 4RG, England. Tel: (0252) 312131. Telex: 858473.
AVX Ltd. Tour Neptune, Défense 1, Cedex 20, 92086 Paris La Défense. Tel: 774. 91. 95.
AVX Ceramics GmbH, Feuerbachstr. 27, 8800 Ansbach. Tel: 0981/5695. Telex: 61760.

Capacitors.

AVX Decoupling Capacitors
Multilayer Ceramic Capacitors for Decoupling Applications.

CIRCLE NO. 231

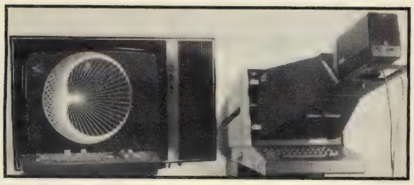
Process indicator takes a range of input devices



Type 208, a digital process indicator with digital alarms, accepts a wide range of thermocouple types and resistance thermometers. The instrument can be custom-scaled for process inputs, such as 4 to 20 mA or 1 to 5 V, and can display engineering units, such as pressure, volume or flow. The single or dual independent alarms are digitally set at any point over a full bipolar 3999 range. Relay outputs are provided. Data interfacing is available via isolated BCD and analog retransmission outputs.

Control & Readout Ltd., Woods Way, Goring-by-Sea, Worthing, West Sussex BN12 4TH. Worthing (0903) 502599. Telex: 877169.
CIRCLE NO. 525

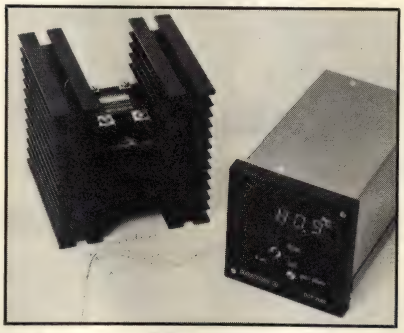
Camera zooms in on nonraster displays



Television camera systems, GDS-2000A and GDS-2000H, add TV compatibility to nonraster alphanumeric and graphics displays, such as Tektronix storage-tube units, laboratory oscilloscopes and nonraster VDUs. A basic GDS-2000 consists of a TV camera mounted on a hood and pivot-hinged to the display. The mount aligns the camera while the hood eliminates ambient light. The GDS-2000A uses a Philips LDH26 camera with 550-line resolution. In addition, it provides a more sophisticated mount to give multilens, variable image magnification features with the use of a zoom lens. The GDS-2000H uses a broadcast-quality caption camera. A GDS-2001 parallel extension keyboard allows remote control of the master terminal while viewing locally on a TV monitor.

Graphic Display Systems Ltd., 76 Hemingford Rd., Cambridge, CB1 3BZ, England. Cambridge (0223) 51645. Telex: 817135 Omnfit G. **CIRCLE NO. 526**

Temperature control holds to 0.1 C



An indicating temperature controller, DCP-2000, maintains its setpoint accuracy to better than 0.1 C. The controller is a half-cycle proportional type with a zero-crossing switch to reduce wear and tear on the load and minimize RFI caused by current surges. Loads of up to 10 kW can be switched with currents of up to 45 A at 240 V. A wide range of input sensors is accommodated, including thermocouples, platinum resistance bulbs and thermometers. Features include drive status indication and an open-circuit thermocouple fail-safe device. The controller's case is designed for panel mounting in a 96 × 96-mm cut-out.

Ancom Ltd., Devonshire St., Cheltenham GL50 3LT, England. (0242) 513861. **CIRCLE NO. 528**

GaAs FET delivers 45 mW at 18 GHz

A power GaAs FET, the GAT 6/020, puts out 45 mW of power at 18 GHz for a gain of 6.5 dB (at 1-dB compression). The device is characterized by its use in amplifier and oscillator circuits in communications, radar and electronic warfare equipment. Presently available from stock in chip form, the GAT 6/020 is expected shortly in a packaged version.

Plessey Optoelectronics and Microwave Ltd., Wood Burcote Way, Towcester, Northants NN12 7JN. (0327) 51871. Telex: 311442.
CIRCLE NO. 529

LED/detector pair operates at 1.3 microns

A light-emitting diode, CXL 011, and a matching detector, CXL 200, complement each other for fiber optic transmission at 1.3 microns. The peak detection wavelength corresponds to the most favorable transmission properties of silica-based fibers. Principal application for the emitter and detector will be in 144-Mbit PCM trunk-routing networks. The emitter is made of gallium indium arsenide phosphide and has a 50-MHz bandwidth and a radiance of 20 W/steradiam/cm^2. The device can launch about 20 μW into a 0.2-NA fiber. The detector is fabricated from gallium indium arsenide epitaxial material and has a sensitivity of 0.35 A/W at 1.3 microns. Rise time is 1 ns.

Plessey Optoelectronics and Microwave Ltd., Towcester, Northamptonshire, England.
CIRCLE NO. 527

Contact your Electronic Design representative

For Rates and Dates-call, write, twx:

UNITED KINGDOM, SCANDINAVIA
Constance McKinley
50 Essex St., Rochelle Park, NJ 07662
Phone: (201) 843-0550; TWX: 710-990-5071

BELGIUM, HOLLAND, SWITZERLAND
W.J.M. Sanders, S.I.P.A.S.
Raadhuisstraat 24-P.O. Box 25
1484 EN Graft-de-Ryp, Holland
Tel: 02997-1303 and 3660
Telex: 13039 SIPAS NL
Telegrams: SIPAS-Amsterdam

FRANCE
Annick Wolff, Promotion Presse Internationale
7 ter Cour des Petites Ecuries
75010 Paris, France; Tel: 247-12-05

ITALY
Robert M. Saidel, Technimedia International
Piazzale Cadorna 4, 20123 Milan, Italy
Tel: 80 16 46: Telex 25897 Utidioma

GERMANY
Annemarie McCalla
50 Essex St., Rochelle Park, NJ 07662
Phone: (201) 843-0550; TWX: 710-990-5071

TOKYO
Haruki Hirayama, EMS, Inc.
5th Floor, Lila Bldg., 4-9-8 Roppongi
Minato-ku, Tokyo, Japan; Phone: 402-4556
Cable: EMSINCPERIOD. Tokyo

Electronic Design

---

the nr. 1 european manufacturer of: mini modular power supplies and dc/dc converters.

AC-DC POWER SUPPLIES

- Output voltage: 5 to 180VDC, single to quadruple
- Output current: up to 4 Amp.
- Line regulation: up to 0,01⁰/o
- Load regulation: up to 0,05⁰/o
- Isolation voltage: up to 4000 V
- Isolation resistance: up to 1000 Mohm
- Leakage current: 10 µA
- Coupling capacitance: 100 pF
- MTBF 150.000 hours, 100⁰/o burn-in
- Short circuit protected, current fold-back available
- Input voltage available 220VAC, VAC, 100VAC and 240VAC

ASK FOR THE NEW 1980 CATALOG

SWITCHING REGULATORS

- Output voltage: 5 to 24VDC
- Output current: up to 8 Amps
- Wide input range: up to 200⁰/o
- Cool operation efficiency to 85⁰/o
- MTBF 150.000 hours

DC-DC CONVERTERS

- Output voltage: 5VDC to 250VDC, single to quadruple
- Output power: up to 25 Watts
- Line regulation: up to 0,05⁰/o
- Load regulation: up to 0,05⁰/o
- Isloation voltage: 300 VDC (min.)
- Efficiency to 85⁰/o
- MTBF 150.000 hours
- Short circuit protected

KRP

Contact KRP or your local KRP distributor

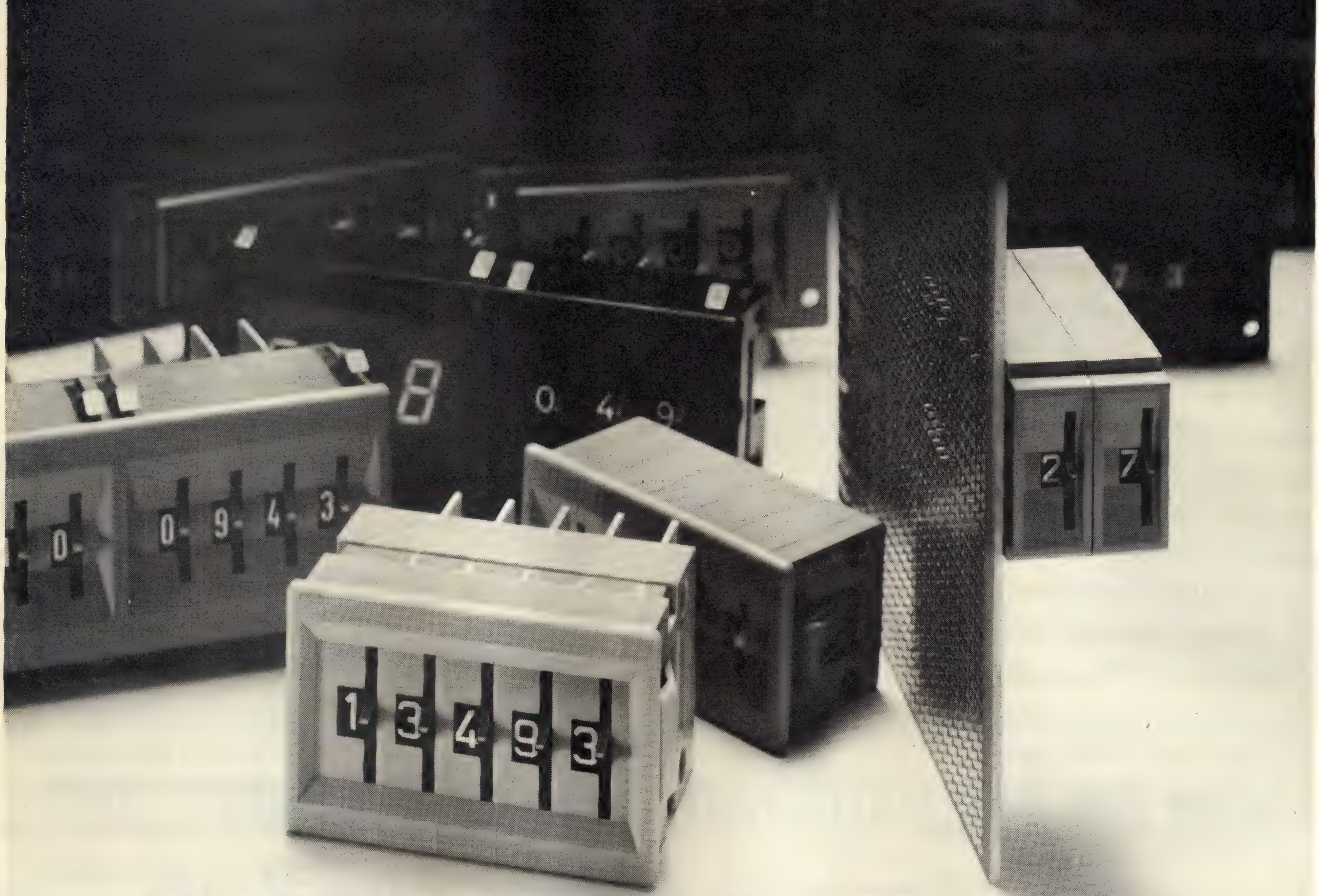
PARIS	235 31 39	ZURICH	45 13 00	STOCKHOLM	83 00 20
GLOSTRUP	45 18 22	HAIFA	53 21 67	BREDA	87 92 50
MUNICH	6 11 81	OSLO	16 26 10	HELSINKI	50 22 55
PORTO	38 26 65	VIENNA	578 230 0		

Mon Plaisir 81, 4879 AL Etten - Leur, Holland, Tel.: 01608 - 21350, Telex: 74131 (krp nl).

CIRCLE NO. 239

contraves

Contraves has the right switch to fit your application



The Contraves range now includes 16 Multiswitch *series of models with hundreds of coding possibilities, lots of ancillaries and innumerable combinations. Many are available from stock.*

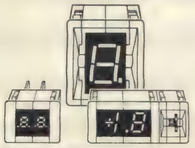
We have been active in the digital component field for over twenty years, so we can offer you the right product for your particular application.

Send for technical information today. We'll be glad to answer your inquiry.

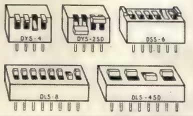
NEW!
The Multiswitch *T range*

A unique switch for on-board mounting. Get more information on this component designed for tomorrow's technology.

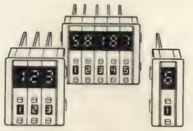
Further Contraves products



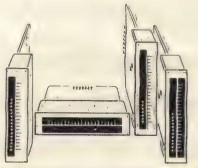
Contraves Codicount,
7-segment LED displays



Contraves DIP-Switch,
dual in-line switches



Contraves Multicount,
switch/display modules



Contraves LED-Line,
solid state analog displays

contraves

Contraves AG, Schaffhauserstrasse 580, Postfach, CH-8052 Zürich, Telefon 01/306 22 11
Contraves Industrial, Products Ltd., Times House,
GB-Ruislip/Mddx HA4 8LH, Telefon (08956) 30 196

Subsidiaries: Germany: Contraves GmbH, D-8013 Haar/München, Italy: Prodotti Industriali Contraves S.r.l., I-20 133 Milano, Japan: K. K. Codix, 1-9-15 Kaigan, Minato-ku, J-Tokyo

MA/1/80

CIRCLE NO. 237

Avantek delivers the highest power, widest dynamic range amplifiers at 10-100MHz.

A modular amplifier that reduces total system cost—from design through production.

Avantek's new VMOS amplifier, the UTO-161, combines the cost saving convenience of a TO-3 package with the highest power and widest dynamic range available over 10-100MHz frequency range. The UTO-161 provides a 1 watt output at +15V and a 2 watt output at +20V. And, with a noise figure of only 6dB you can now solve those tough receiver problems. The TO-3 package with BeO substrate provides optimum heat transfer and drops right in your board, eliminating the complexity of using connectored amplifiers.

WIDE DYNAMIC RANGE AMPLIFIERS
Guaranteed Specifications from −54° to +85°C

Model	Freq. (MHz)	Gain (dB)	Noise Figure (dB)	Power Out (dBm)
UTO-161 (VMOS)	10-100	8.0	6.0	30/33
UTO-543	10-500	9.0	3.0	6.0
UTO-544	10-500	9.0	3.5	12.0
UTO-545	10-500	10.0	5.5	16.0
UTO-1043	10-1000	9.0	4.5	6.0
UTO-1044	10-1000	9.0	5.0	12.0

Off-the-shelf delivery for your immediate application.

Avantek modular amplifiers are available off-the-shelf in a wide choice of bandwidth, gain, power output and noise figure performance specifications. Each is designed to protect small signals against large signal overload for maximum preservation of system sensitivity. And, Avantek has over 90 different modulars, including oscillators, attenuators, limiters and mixers.

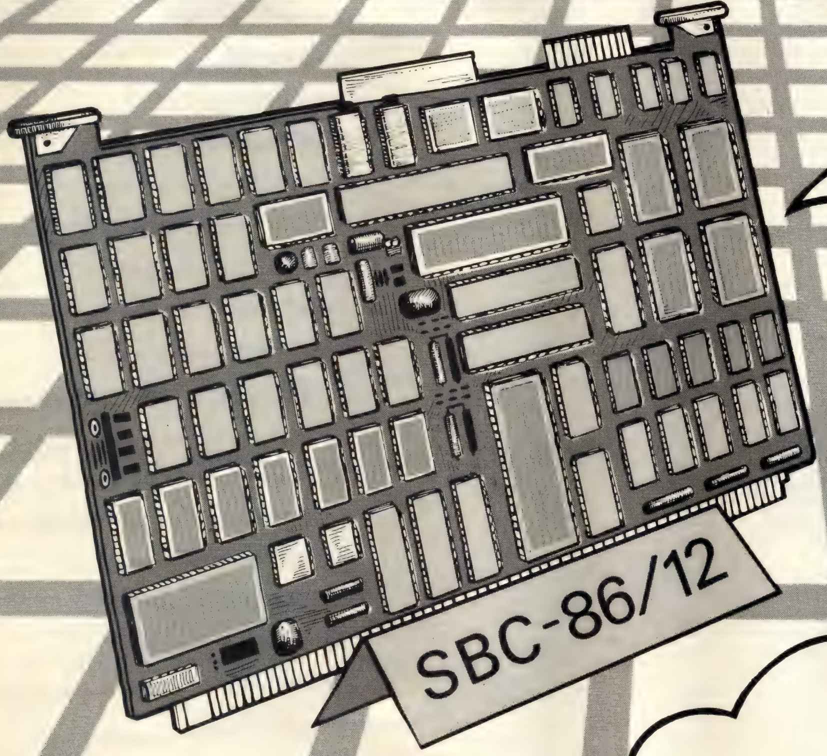
Free information.

Call or write today for free data and applications information on Avantek's complete line of modular products. We'll send our 85-page applications manual, "Designing with Modular Amplifiers." Avantek, Inc. 3175 Bowers Avenue, Santa Clara, California 95051, (408) 727-0700.

Avantek

© 1980 Avantek, Inc.
Avantek is a registered trademark of Avantek, Inc.

CIRCLE NO. 26



I need a real-time, multi-tasking operating system.

Try polyFORTH!

If you are planning to use an SBC-86/12 board in your final system, you have the principal components of a development system already: a CPU, plenty of memory for most applications, and a serial port for a CRT. This simple addition of an SBC-204 disk controller provides the final ingredient for a powerful development system in which you can fully test your application **software and hardware** interactively, without needing cumbersome in-circuit emulation.

polyFORTH is a complete stand-alone operating system and programming language. The modular nature of FORTH promotes structured programming and interactive debugging, leading to reduced development time.

A specially designed utility, the Target Compiler™, allows easy generation of programs to be run from ROM in a target system.

The polyFORTH system is organized to operate out of PROM (8K bytes) with the disk as a peripheral.

Let us tell you more. Send the coupon, attend a free seminar, but first give us a call at:

213/372-8493

OK, I'm interested!
Please rush full details on polyFORTH for
____________ *microprocessors*
____________ minicomputers
☐ Contact us for immediate requirements
Tel: (   ) ____________________
☐ Send dates and locations for your polyFORTH Seminars.

Name ________________________

Title ________________________

Attach coupon to company letterhead, and return to:
FORTH INC., 2309 Pacific Coast Highway,
Hermosa Beach, CA 90254. Or call (213) 372-8493.

FORTH, Inc.

CIRCLE NO. 59

Technology

The Winchester world is a hotbed of developments, with 8-in. backup alternatives, 5-1/4-in. contenders, controllers and standards emerging.

World of Winchesters —wide and getting wider

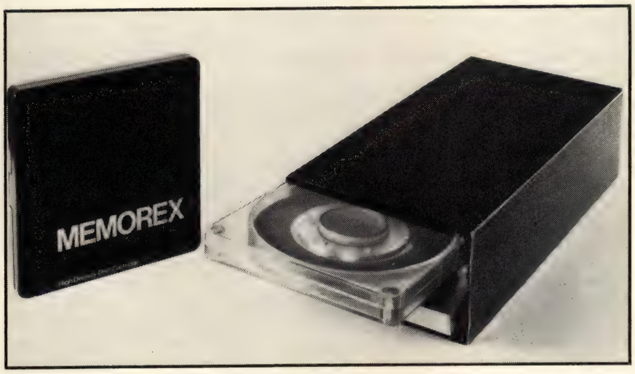
With microcomputer-based systems shrinking yet requiring increased storage capacity, Winchester-disk drives are gearing up to fill that need. Sounds simple enough, except that in the OEM Winchester-disk marketplace, nothing is simple:

- Backup remains a key obstacle to 8-in. progress, but two systems that combine fixed disks with removable platter backup should go a long way to clearing that up. They had better. Even as 8-in. systems struggle for design acceptance, 5¼-in.-disk systems are bursting onto the scene.
- While removable backup media look promising, other backup media are now delivering—¼-in. cartridge and ½-in. reel tape drives.
- Interfacing, another 8-in. obstacle, is being gradually knocked down through the efforts of the ANSI X3T9 Technical Committee, which is on the verge of producing a standard for 8-in. rigid-disk drives.
- In the absence of any industry-standard interface, disk makers are offering their own controllers.
- Major campaigns are underway, fueled by increased R & D dollars, to develop new heads and media to feed the growing hunger for even more disk and tape storage capacity.
- Meanwhile, the parade of new products seems unending as Japanese manufacturers ship in 8-in. offerings and optimists start spin-off companies to produce still more 8-in. units.

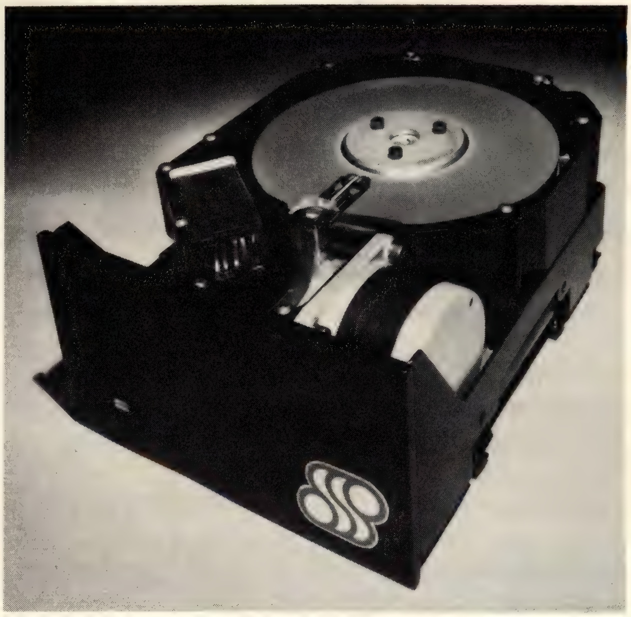
The race to produce the first fixed Winchester with removable platter backup is heating up: Control Data Corp.'s (Minneapolis, MN) long-awaited Lark module (ELECTRONIC DESIGN, Dec. 6, 1979, p. 21) will share the spotlight with Memorex's (Santa Clara, CA) Model 201 drive at NCC this month in Anaheim, CA. Besides bringing a 12.5-Mbyte removable platter together with a 12.5-Mbyte fixed disk, the 201 boasts technological enhancements that make it a very

---

Jonah McLeod, Instruments Editor



Memorex's Model 201 is one of the first 8-in. Winchester-disk drives to have its own removable cartridge. Total drive capacity is 25 Mbytes, with half of the storage in the fixed portion and the other half in the removable cartridge.



First of the 5-1/4-in. floppy-disk drives, the Shugart Technology ST506 contains two platters providing 6.38 Mbytes of unformatted capacity. It uses a stepper-motor actuator and sports a standard floppy-disk interface.

competitive rival.

Using a single linear voice-coil positioner and heads ganged together, the unit offers a 30-ms average access time with an 8.3-ms average latency. In concert with the drive's intelligent electronics—it has its own control microprocessor—data travel between disk and CPU at 1.2 Mbytes/s. Drive capacity? Each track, unformatted, has a maximum capacity of 19,968 bytes, composed of 32 sectors per track and 512 bytes within each sector.

Two servos

Innovative technology helps achieve the specifications. According to Dr. John Scott, Memorex Mini Disk Drive Co. President, the drive sports two servo schemes, an imbedded servo mechanism in the removable portion and a dedicated servo in the fixed portion, used in combination with the imbedded servo within each track. Other disk drives are limited to one or the other technique. During normal 201 operation, the dedicated servo provides a coarse indication of track position while the imbedded servo information—contained in each sector heading within a track—tells the disk exactly what track the head is on.

This dual capability not only increases reliability, says Scott, but it also allows Memorex to increase the number of tracks per inch later, when more storage capacity is needed. This will occur as the family of products continues to grow.

With a product containing fixed media—sealed from the potential contamination of computer rooms or offices—and removable media—which is subject to contamination—exactly what reliability and data integrity can be expected? According to Scott, data integrity won't be affected and total mean-time-between-failure (MTBF) may be slightly less than that of a completely sealed Winchester disk. However, the problem has been directly addressed in the design of the cartridge, Scott points out, citing patents pending on the technique for sealing the cartridge case containing the removable platter.

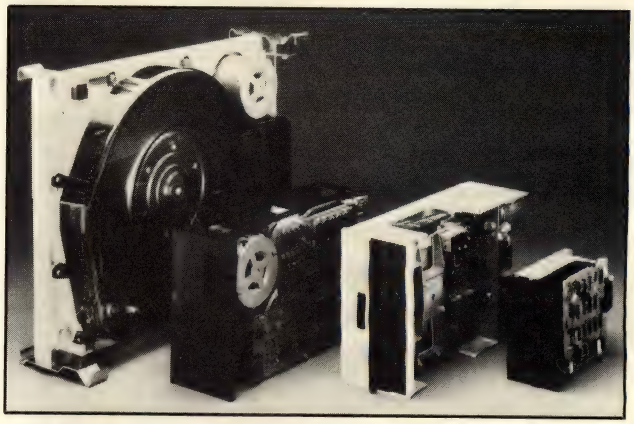
Square in shape, the case loads in the front of the drive. Once it is inserted, a door in the cartidge opens to allow the heads access to the media. While a prototype case exists, the final form and size are not yet final, probably to allow a *de facto* standard to be established first.

Like the Memorex offering, CDC's 9455 Lark Module packs new technology, the foremost being its modified frequency modulation (MFM) recording technique. What MFM buys is denser recording. While the company won't comment on the actual density achieved, it states that density is greater than the number of flux reversals called out in the drive's specifications: approximately 6800 reversals for the inner track and 5100 for the outer track.

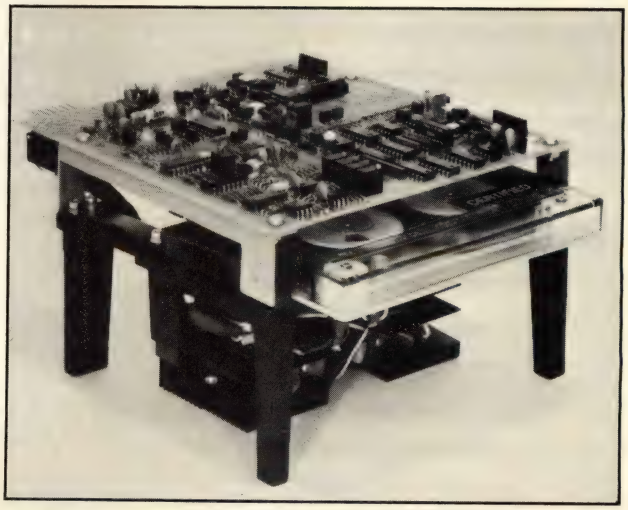
Also new on the Lark are proprietary heads that, besides not being of Winchester design, are able to unload. What's more, the heads in the removable part of the drive, the 91208 cartridge, do not require the use of a head-alignment pack.

Other features of the CDC drive include a maximum storage capacity of 8 Mbytes both for the fixed drive and for the removable cartridge. Transfer rate is 9.67 Mbits/s; average latency is 8.5 ms; average access time is 62 ms; and track density is 237 tracks per inch with 302 tracks on a surface. The disk media rotate at 3510 rpm.

The cost of all this? In OEM quantities, $2700 each, with the cartridge costing under $100. Evaluation units are expected to be available in November of 1980, while production is scheduled to begin in the



Shugart Associates' family of products includes 14-in. and 8-in. Winchesters as well as 8-in. floppies, offering storage capacities from 40 Mbytes down to 250 kbytes. All use a low-cost stepper-motor actuator.



Streaming-tape capability on a 1/4-in. cartridge tape drive is the forte of Data Electronics' "Streamer" tape drive. Form-factor-compatible with most 8-in. Winchesters, the streamer can provide 10 or 20 Mbytes of backup storage for disk subsystems.

first quarter of 1981.

Even as removable platters promise to serve as backup for Winchester disk drives, two different tape products have become available to handle that chore: ¼-in. cartridge-tape and ½-in. streaming-tape drives.

Tape products tend to split into two market segments: those requiring 10 to 20 Mbytes of disk storage and those needing backup for 20 to 200-Mbyte products. To fill the first, a ¼-in. cartridge offers sufficient backup capacity for a moderate price—in some cases, under $800 in OEM quantities. What's more, variety spices the ¼-in. realm with, for example, recording techniques ranging with the manufacturer. Two good examples are Data Electronics Inc. (San Diego, CA) and 3M (St. Paul, MN).

Group code recording (GCR) can be found in DEI's Data Streamer. While this method is associated with higher packing density, the DEI version concentrates on improving the drive's error-correction capability. As described by DEI, GCR reduces error by replacing susceptible bit patterns with more "benign" coding. This occurs automatically as data from the tape interface are brought into the drive, GCR-coded and then written to tape.

How does the Streamer offer its high storage capacity of 10 and 20 Mbytes? By using a streaming data-recording mode in which data are written linearly along a track in a serpentine fashion back and forth along the track, without interrecord gaps. In effect, the tape appears to the outside world as a FIFO (first-in, first-out) memory. High packing density results, in part, from the removal of the interrecord gaps, which normally require ½ in. of tape in conventional start/stop recording. Even higher density results from the streaming method. The upshot: Data are stuffed in at a tight density of 7500 bits/in. Other benefits: a 675-kbit/s transfer rate and a tape speed of 90 in./s.

The 3M cartridge takes a different technological approach to recording. First the drive puts a block format on tape, rather than a continuous stream. While data are recorded along a single track in streaming fashion, the track is blocked into 1024-byte segments, to facilitate error correction. This technique requires that for every four data blockettes of 256 bytes, two 256-byte blockettes of error correction data be written.

All told, then, six 256-byte blockettes store the equivalent of four 256-byte blockettes of data. While this might seem wasteful, not much is lost since the drive records a big 67 Mbytes of data using 16 tracks and a bit density of 10,000 bits/in. Moreover, this is done using a single ferrite head.

While the 3M's capacity appears to be its strong suit, some believe it's a liability. DEI, which announced a 34-Mbyte cartridge in the summer of 1979, drew back when the lower-capacity design attracted more interest than the denser unit. Hence, there is reason to believe that the 67-Mbyte capacity of the 3M unit may be more than most designers are currently willing to buy. Whether that position remains valid as the capacity of Winchester disks begins to rise remains to be seen. But one thing is certain. The designer is cost-limited with the newer 8-in. drive, and price will be the determining factor in winning acceptance.

Winchester backup requiring more than 20 Mbytes of disk storage is easily handled up to a point by 3M's cartridge, which offers 67-Mbyte capacity.

For applications calling for 20 to 200 Mbytes of backup, the likely choice is the 6809 1/2-in. streaming-tape cartridge from Kennedy. Capable of both streaming and start/stop operation, the reel-to-reel drive offers 46 Mbytes of backup storage.

Another manufacturer of cartridge tape drives is Kennedy (Monrovia, *CA*). Kennedy's Model 640, closely resembling the DEI drive, is characterized by four-track, read-after-write heads and a transfer rate of 192 kHz with modified-frequency-modulation recording. Maximum storage capacity of the drive is 17.3 Mbytes, recording speed is 30 in./s, and rewind and search proceed at 90 in./s.

A three-point suspension system in the 640 extends tape life by eliminating cartridge warping. In addition, because of the drive's low-power servo motor, power consumption is held to 10 W during read/write and an even lower 4 W during idle. Voltages required are the standard 5 V dc and 24 V dc.

For larger-capacity disk drives—those in the 20 to 200-Mbyte range—streaming ½-in.-tape drives are ready to go. Cipher Data Products (San Diego, CA) and Kennedy both offer backup products that attack the problem similarly—with a low-cost drive, lots of electronics, and no vacuum columns or tension arms.

Both the 6809 from Kennedy and the F880X from Cipher (see ELECTRONIC DESIGN, Jan. 4, 1980, p. 29) use adapted versions of the streaming-tape technique introduced on the IBM 8809 drive. In the streaming mode, both record at 1600 bits/in. and offer 100-in./s tape speed. Other "shared" specs include an error rate of 1 in 10^{10} bits and a total of four minutes for a 40-Mbyte transfer. However, while both offer start/stop operation, the Cipher operates faster than the Kennedy—25 in./s to 12.5 in./s.

There are other differences between the two, primarily in operator features, packaging and price. On the Cipher, automatic loading is standard; there's no provision for manual loading. Tape is inserted into a slot in the front of the tape drive. On the Kennedy, the operator loads tape as he would on any reel-to-reel drive. The Kennedy unit mounts vertically or horizontally, the Cipher only horizontally. In addition, the Kennedy 6809 comes in at $2500 (OEM quantity) and the Cipher F880X at under $2000.

The direction for large-capacity tape drives is clear —even greater capacities and higher throughputs, dictated by the disk. However, any capacity increase must compensate for a long-standing rule, according to Cipher's vice president of marketing, Larry Hemmerich: Disk-to-tape dumps should take no more than 15 minutes. To deal with all three requirements, next-generation backup tapes will have to step up to double-density recording; with its higher data rates. That density could easily yield an 80-Mbyte capacity in either the Cipher or Kennedy drive.

Ultimately, however, the answer lies with new codes that will permit still higher-density recording without a decrease in data reliability. The obvious step is toward 6250-bit/in. recording capability using the IBM-developed GCR code. Here, the problem is one of cost. While the density gain would be high, 170 Mbytes on a 10-in. reel, the cost would double. However, this would be offset somewhat by the high data reliability GCR would bring: As implemented by IBM, the code can correct errors with two tracks missing out of a drive's nine whereas conventional error correction can manage only one missing track.

One other silver lining in the cloud of higher GCR costs is the ease with which a streaming drive can adapt to the rigorous requirements usually placed on a conventional reel-to-reel tape drive equipped with GCR. In start-stop operation, the technique calls for an interrecord gap of 0.3 in., whereas the IRG is typically 0.6 in. with conventional recording techniques. During normal operation, a conventional drive with GCR must ramp up to speed in approximately 0.15 in. The result is an enormous stress on the drive's mechanical components.

In the streaming-tape drive's start-stop operation, the drive overwrites or overreads an IRG, then automatically reverses and returns to the start of the gap to await the next read/write command. Therefore, much less mechanical stress is placed on the drive—but only at the expense of speed.

Probably the best solution is the lower-cost formatter supplied by chip makers, third-party vendors, or the tape suppliers themselves. But demand for the formatter still awaits higher-capacity disks for which the most cost-effective back-up will be GCR-formatted ½-in. tape.

A special design allows the Cipher Data Products F880X 1/2-in. streaming-tape drive to provide automatic front loading of reel tape, 40 Mbytes of backup storage and two modes: 100-in./s streaming-mode or 25-in./s start/stop-mode tape speeds.

Meanwhile, the Winchester spectrum is being extended by an even smaller product—the 5¼-in. rigid-disk drive. Shugart Technology's (Scotts Valley, CA) ST506 (ELECTRONIC DESIGN, April 26, 1980, p. 31) offers 6.38 Mbytes, unformatted, 5 Mbytes formatted.

Most significant, the ST506 is compatible with the 5¼-in. floppy disk's dimensions of 3.25 × 5.75 × 8 in. However, the 506 differs from its slower companion in interfacing. It sports a Shugart Associates (not to be confused with Shugart Technology, a spin-off) SA1000 8-in. rigid-disk interface, not the standard floppy interface.

Moreover, while not breaking any new technical ground, the drive offers some useful twists. For example, unlike the low-cost Shugart Associates 8-in. drive, the new drive uses no ac motor, but substitutes a brushless dc motor—good bye, ac requirement. Voltage required for drive operation is the same as that of a 5¼-in. floppy: 12 and 5 V dc. Second, as the first of its kind, the ST506 sets a size standard for the media: 130-mm outside diameter and 40-mm inside opening diameter.

Within the drive, two disks offering four surfaces and four read/write heads yield an average access time of 170 ms and a track-to-track access time of 3 ms. Data move from disk to CPU at 5 Mbits/s. In addition, the unit weighs a mere 3½ lb and consumes a low 30 W, which makes it ideal for small business systems, word processors and other microcomputer applications.

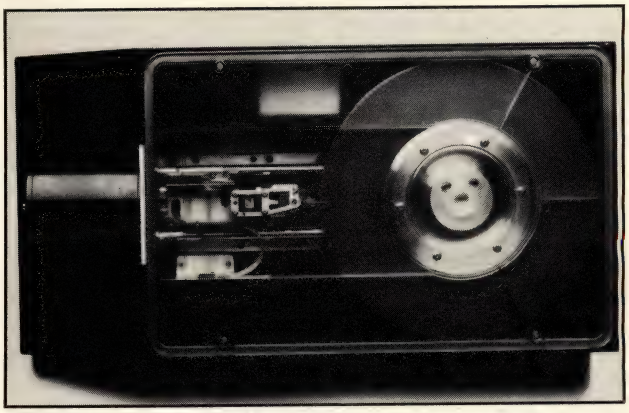
Finally, Shugart Technology has addressed the interface problem by entering a joint venture with Western Digital (Newport Beach, CA) to produce, first, a board-level controller, and, second, a chip version. According to Finis Conner, Shugart Technology's executive vice president, both controller/formatters will offer integral error correction and data separation. Both will support the Winchester 5¼-in. drive with floppy disk for backup and data input. Both will interface the S100 bus, and both will handle a daisy chain of up to four rigid-disk drives. Initially, however, the board will require data transfers to occur through the system CPU; the LSI chip will perform this function itself.

Besides Shugart Technology, a number of other companies are working on a 5¼-in. hard-disk drive. According to industry observer Ray Freeman, president of Freeman Associates, likely entries include Tandon Magnetics (Chatsworth, CA) and Irwin Industries International Inc. (Ann Arbor, MI). Britton & Lee (Saratoga, CA) is known to be developing both low-end and high-performance products. And Trans Data Corp. (Belmont, CA) reportedly has a 5¼-in. program underway.

While Shugart Technology is taking its own tack in the sea of interface standards, the ANSI X3T9 technical committee is making headway toward a standard for 8-in. rigid-disk drives. As of now, X3T9, 3/143 Revision 1 has been approved by the committee's task group and Revision 1A is about to be voted on. According to Gary Robinson, chairman of the committee, the standard is now firm enough for designers to begin using.

Technically, the standard contains the ability to address a great many more locations than most of today's 8-in. products, affording considerable room for the new class to grow before the standard becomes obsolete. Likewise, the drives and interface electronic components are specified so that they can

First of the 8-in. drives, the IMI 7710 comes with 10 Mbytes of storage, a high-performance linear actuator and its own controller in two forms, either as a separate board or as an integral part of the disk electronics.



The 6170 8-in. disk from BASF provides 10 and 20 Mbytes of storage capacity and, unlike many other disks, sports a board-level controller providing a host bus interface to microprocessor-based systems.

accept faster operating speeds in anticipation of future technology improvements. In addition, the interface has been designed so that timing information governing data transfer between drive and controller comes from each disk. This allows drives of varying operating speeds to function on the interface.

The standard is the first to be largely accepted by the suppliers currently supporting the committee's work. This is particularly important because of the large number of interested parties, including American, European and Japanese Winchester manufacturers, as well as controller and chip suppliers waiting to ship support products for the Winchester drive.

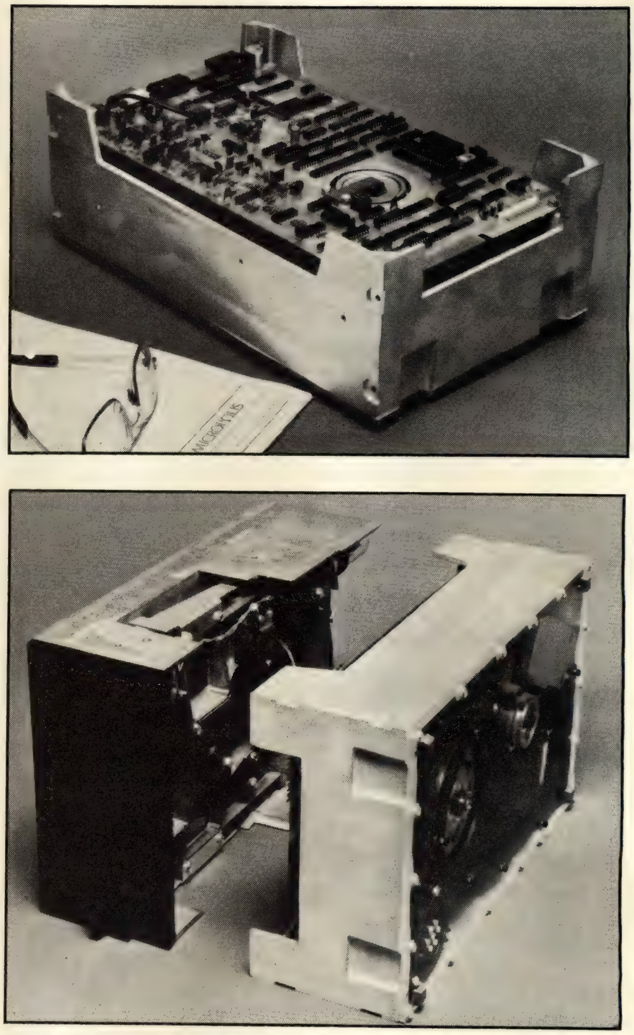
Physical characteristics, signal-line definitions, command structures and timing specifications are all spelled out. In its statement on physical form, the standard calls for a 50-conductor, flat-ribbon cable for interconnection. Cumulative length formed by a daisy chain on the cable can be no longer than 3 meters, and the number of drives in the chain no more than eight. In addition, drive ac and dc power must be supplied independently of the cable.

Signal-line definitions include electrical specifications for each line, of which there are three types among the 30 specified. Bidirectional lines (pins 1 through 12 of the interface) form a control bus between the controller and drive, and are used for drive selection and for command and parameter transfer between controller and drive (see Table). In the table, the bus consists of signal and ground pins for bus bits 0 through 7 and parity.

One salient feature of the control bus is its ability to accept either a daisy-chain or radial configuration for drive interconnection. In the radial arrangement, each drive connects independently to the controller. While costing more, this method affords greater reliability since each drive operates independently of others tied to the controller.

Besides the control bus, single-ended lines (interface pins 13 through 37) carry control signals from the control unit to the drive and status signals from the drive to the controller. Differential lines (pins 39 through 50) carry data and clock signals between the drive and control unit. To ensure high-speed, signal-carrying capability for present-generation products and, more importantly, for the higher transfer rates that can be expected on products to come, these lines are spec'd to operate at 10 MHz.

Within the command structure to be used during communication between controller and drive, the command protocol defines a command as containing two bytes, the first a command-control byte, the second a parameter byte. Of the two, the former is always a directive from the controller to the drive that calls for some function to occur, e.g., "set lower cylinder address," "write control," and so on. The second byte is a parameter supplied to the drive by the controller along with a command directive or a status byte supplied by the drive to the controller in response to a previous command.



From Micropolis comes the MicroDisk 1200 Series 8-in. drive (shown at bottom alongside a floppy disk). This product is the hardware core of a disk operating system, also sold by the company, that offers software as well as controller electronics for easy integration into Z80, 8085 and 8080 microprocessor-based systems.

In addition, special codes allow a number of optional commands as well as commands that differ from the standard's—the latter from individual vendors—to be used with the ones covered by the standard.

The interface standard contains a comprehensive section that details error reporting and calls out both general-status and error-status words. The standard also sets down the interface timing requirement, detailing timing for the control bus, index and sector, reference clock, and read, write and address marks.

Although backup is an ongoing hurdle facing the disk maker, a more pressing problem involves tying his disk drive into a computer system. A standard for 8-in. Winchesters would go a long way to encourage greater development of third-party controllers.

Controllers are here

However, the lack of standards has not prevented some controllers and complete disk subsystems from becoming available. Some of these products simply tie to specific computers like the Digital Equipment Corp. PDP-11 or to standard buses like S100 and Multibus.

Disk manufacturers currently building 8-in. controllers include International Memories Inc. (Cupertino, CA), BASF (Bedford, MA) and Shugart Associates. Micropolis (Canoga Park, CA) offers complete subsystems. From IMI come two products, one of which is a board that mounts inside either of the company's 8-in. drives, the 10-Mbyte 7710 or 20-Mbyte 7720. Designated the Model 7711, the board provides all external controller functions, including format, read and write, and ties into the parallel input/output (PIO) port of any microprocessor system. Moreover, the unit can daisy-chain up to eight Winchester drives to the CPU.

The second IMI product is an integral controller that is part of the μP-based intelligence controlling the disk-drive operation. It supports all the functions of the board product except daisy-chaining.

BASF's board controller fits into the drive itself. The optional controller provides what product manager Carter O'Brien describes as a host bus interface with the system CPU. In this configuration, the controller's 16-byte FIFO buffer transfers commands, status and data over a byte-parallel bus operating under an asynchronous handshake protocol. Thus, designs with a few standard low-cost peripheral chips can easily interface with the disk and controller.

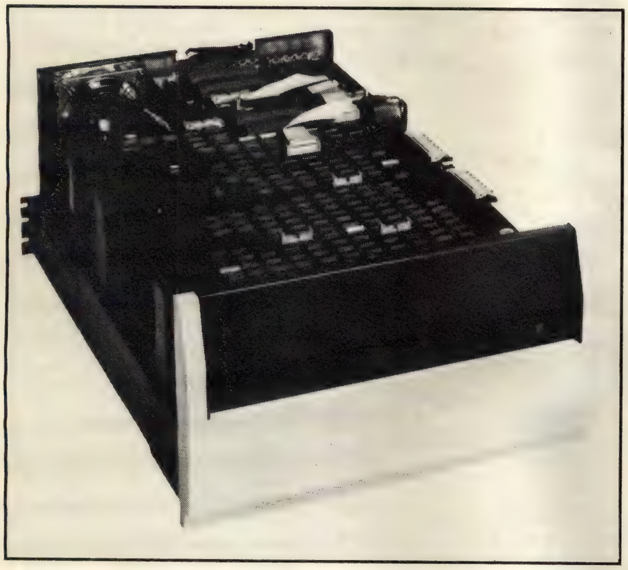
The controller also brings with it high-level language capability, including such commands as Format, Retry, Abort, Verify, Seek, Set-protect, etc. In addition, the controller accommodates a daisy-chain connection of up to seven disk drives.

Standard-interface pin assignments

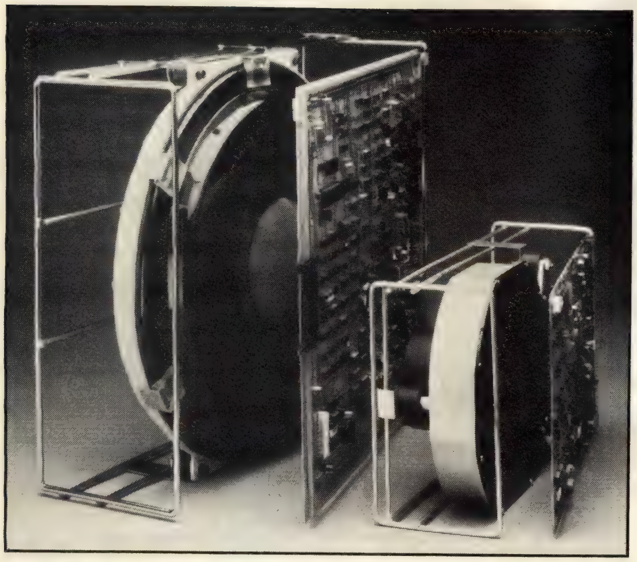
Signal pin	Ground pin	Signal name	Signal source
—	1	Ground	- - -
2	10	Bus bit 0, Select/Attn Drive 0	Control unit/drive
3	10	Bus bit 1, Select/Attn Drive 1	
4	10	Bus bit 2, Select/Attn Drive 2	
5	10	Bus bit 3, Select/Attn Drive 3	
6	10	Bus bit 4, Select/Attn Drive 4	
7	10	Bus bit 5, Select/Attn Drive 5	
8	10	Bus bit 6, Select/Attn Drive 6	
9	10	Bus bit 7, Select/Attn Drive 7	
11	12	Bus Parity (optional)	
13	14	Select Out/Attn In Strobe	Control unit
15	16	Command Request	
17	18	Parameter Request	
19	20	Bus Direction Out	
21	22	Bus Enable	
23	24	Address Mark Control (optional)	
25	26	Read Gate	
27	28	Write Gate	
29	30	Bus Acknowledge	Drive
31	32	Index	
33	34	Sector/Address Mark Detected	
35	36	Busy	
37	36	Attention	
39	38	Read Data +	Drive
40	38	Read Data −	
42	41	Read/Reference Clock +	
43	41	Read/Reference Clock −	
45	44	Write Clock +	Control unit
46	44	Write Clock −	
48	47	Write Data +	
49	47	Write Data −	
—	50	Ground	- - -

Shugart Associates' SA1400 disk controller also offers a general-purpose, host-computer interface. However, for connection to the disk, Shugart opts for its standard floppy interface. To facilitate floppy backup, the drive can accept either floppies or hard disks in any combination of up to four drives. Besides providing minimal capability for system interfacing, the controller offers head and cylinder switching, sector interleaving, overlapped seek, implied seek with position verify, error correction—all automatic operations occurring apart from the CPU. High-level-language capability is also available.

Complex operating subsystems from the disk makers include the MicroDisk from Micropolis. Starting with a 31.2-Mbyte, 8-in. Winchester disk drive, the company has added a multiterminal operating system, called OSM, which consists of software for disk file and memory management, an executive, and software development tools—an assembler, Basic interpreter, file manager and file programmer. The system interfaces to the S100 bus and can immediately plug into a Z80, 8080, or 8085-based system.



From Japan comes the NEC information Systems D-1200 8-in. Winchester line, which brings capacities of 24.9, 47.5 and 74.8 Mbytes.



Priam's DISKOS 3450 (right) is an 8-in. Winchester disk offering 34 Mbytes of capacity and a high-performance linear actuator. The bigger 14-in. brother is at left.

From third-party vendors come a number of controllers for 8-in. drives. Third-party suppliers fall into two camps: those aiming at existing minicomputer systems and those selling to microprocessor-based systems. The former group includes Microcomputer Systems Corp. (Sunnyvale, CA), U.S. Designs (Annapolis, MD), Xylogics, Inc. (Burlington, MA), and Distributed Logic Corp. (Dilog), in Garden Grove, CA. The latter camp holds Lobo Drives International (La Palma, CA) and Data Technology Corp. (Sunnyvale, CA).

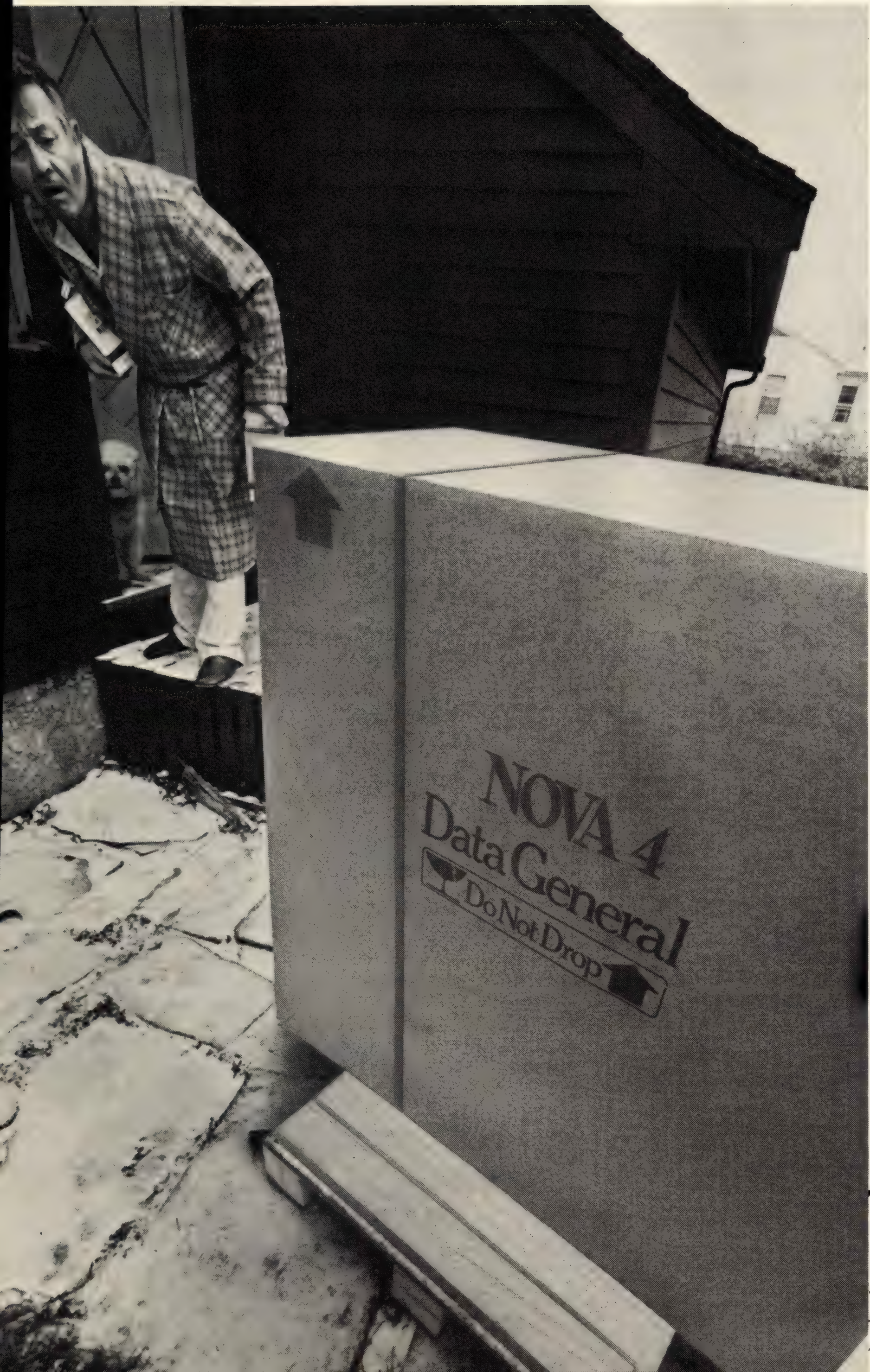
Choice of storage

Products destined for minicomputer-based systems either contain a storage subsystem made up of a controller and both disk and tape backup, or just the controller. Of the first, U.S. Designs offers its μiC-11, which can interface up to 16 IMI 7710/20 Winchester drives and eight DEI 3400 cartridge-tape drives to either the LSI-11/2 or 23. One outstanding feature is the μiC's 16-k cache buffer, which permits a complete track to be read from disk and buffered to speed data access during CPU operations or data transfers to tape during backup. According to Steve Stephenson, U.S. Design's vice president of marketing, there are two ports on the controller, each with its own buffer. If a disk fails, the tape can step in and take over, albeit at a much slower operating speed than the disk.

The Microcomputer Systems Corp. MSC-8000, first shown at the National Computer Conference last year, combines three 8-in. Winchester disks with an integral ½-in. tape drive. The MSC-8000 stores 40 Mbytes on disk and 80 on tape.

Xylogics' Model 530 is representative of products of the second type, those having only the controller function and interfacing an 8-in. drive with a mini-based system. The Model 530 links the BASF and IMI 8-in. drives and the 14-in. Century Data Marksman to the DEC Q-bus, thus tying the disk to the LSI-11/2 and 11/23 computers. Another device, Dilog's Model DU-202, takes any 8-in. or 14-in. drive with an SMD interface and mates it with the DEC Unibus.

Many manufacturers supply controllers for mini-based 14-in. Winchesters, including Charles River Data Systems (Natick, MA), Data Management Labs



OUR NOVA 4 HAS ALL THE LATEST FEATURES. INCLUDING EARLY DELIVERY.

That's why you should contact us right now for fast delivery of one of the most popular, compatible, reliable computer systems ever made – the Data General NOVA® 4.

Our NOVA 4/C is the component OEM's dream come true, combining low price with reliability and flexibility.

The NOVA 4/S offers fast scientific processing through its instruction prefetch processor, high-speed floating point, and character manipulation abilities.

Then there's the NOVA 4/X. It provides all the features of the 4/S, with up to 256K bytes of memory.

And every NOVA 4 is available with our new winchester-type technology disc featuring integral diskette backup.

Whatever your application, there's a Data General NOVA 4 that's a perfect fit. With a delivery date that'll keep you from throwing fits.

Data General Corporation, Westboro, MA 01580, (617) 366-8911. NOVA is a registered trademark of Data General.
©Data General Corporation, 1980.

VISIT US AT BOOTH #1339 AT NCC, ANAHEIM, CA., MAY 19-22, 1980.

CIRCLE NO. 27

Data General

Mail to: Data General Corporation, Westboro, MA 01580
☐ I can't wait. Send complete NOVA 4 info now. ☐ It's a date. Send a salesman fast.

Name
Title
Company
Address
City
State
Zip
Tel.

The Computer of the U.S. Olympic Sports Medicine Committee

ED 510

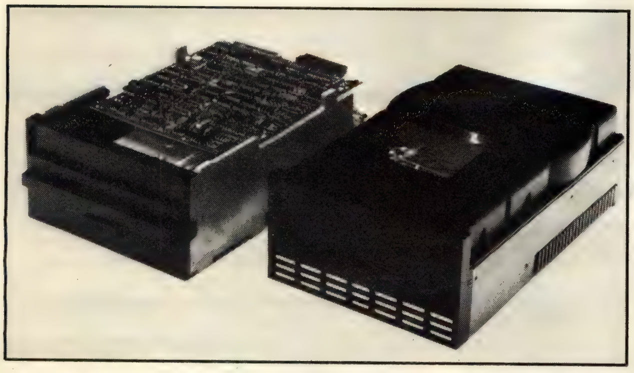
(Sunnyvale, CA), Ball Computer Products (Sunnyvale, CA), Advanced Electronic Design, Inc. (Sunnyvale, CA), *Dataram* (Cranbury, NJ), to name a few.

Third-party vendors making controllers for microprocessor-based systems include Lobo, with its Model 7710 T/A/S. Each of the letters specifies the computer or bus interfaced: TRS-80, Apple, or S100. The controller ties these computers to an IMI 7710 disk drive, and provides operating-system software for the system in question. The controller comes alone or as a complete system, with disk, software and controller.

Other third-party vendors include Data Technology, with its DTC 1KA, which interfaces a Shugart Associates SA1000 or SA4000 series disk to the Multibus, LSI-11, or 6800.

Controllers tying 14-in. Winchesters to microprocessor-based systems are also numerous. They include the Microcomputer Systems Corp. MSC-1088 (interfaces the IEEE-488 bus), Data Management Labs' (Sunnyvale, CA) Intelligent Control Unit 4000 (connects to the S100 bus), Sentinel's (Cincinnati, OH) Multibus-compatible controller, and Digital Microsystems' (Oakland, CA) 8-bit bidirectional parallel bus interface. All zero-in on Shugart's 14-in. SA4000.

A rotary positioner with one, two or three 8-in. platters helps the Kennedy 7000 8-in. disk offer 4, 12 and 20 Mbytes of storage capacity.



With an average access time of 50 ms, nominal data rate of 860 kbytes/s and 20-Mbyte capacity, the Pertec Model D8000 Mini-Wini fits right into the high-performance, rotary-actuator category.

Inside the drive itself, one new development clearly stands out: thin-film heads. So far, they are available on the IBM 3370 direct-access storage device (ELECTRONIC DESIGN, April 26, 1979, p. 34), and on a drive from Dastek (Los Gatos, CA, see p. 97). The Dastek drive uses IBM 3350-type media. A third drive, competitive with the IBM, is expected shortly from Memorex.

With IBM's thin-film head, data rates speed up to 1.86 Mbytes and area density soars to 7.8 Mbits/sq in.—a full 2.5 times greater than in the 3350. But beyond all this, the head is very easy to make. Film-fabrication techniques draw from batch semiconductor processing—photolithography, etching, sputtering—which allows many heads to be deposited simultaneously on a substrate.

Photolithography allows control and improved reproducibility of key dimensions of the head. This not only helps bring manufacturing costs down but also helps produce a better component. (For more on IBM's thin-film head, see ELECTRONIC DESIGN, March 1, 1980, p. 80).

The 3370 itself introduces two major innovations: the concept of multiple actuators on one spindle and a code-compression technique called two-of-seven code. One very interested party is Memorex. According to Steven Puthuff, vice president of engineering at Memorex, two actuators on one spindle permit the drive to appear as if it had two spindles—that is, each actuator accesses mutually exclusive cylinders on the disk: It does not overlap cylinders of the second actuator. The benefits? Smaller size and lower cost. But by having the two overlap, the next logical step in product evolution, better and faster data access will result as well, according to Puthuff.

Code compression, though not common among disk manufacturers except for ISS (Santa Clara, CA) with its 3-PM code, will become the norm, Puthoff predicts. The IBM 3370's two-of-seven code puts down the equivalent of 12,000 bits/in. for approximately 8000 flux changes/in.—quite an inducement.

Why is Memorex so interested in IBM's developments? Because the company, which first tested thin-film heads in December of 1978, is currently developing its own large-capacity, thin-film-head disk drive to compete with both the 3370 and the next-generation IBM product. Following its established

Introducing the HS5200 Series ADC's:

Designed for the new MIL Specs...

And packaged like a tank.

In response to emerging military standards for high-rel 12-bit ADC's, our new HS5200 Series offers adjustment-free performance . . . at an attractive price . . . with the highest levels of reliability. And it's packaged for ruggedness and true hermeticity.

Others talk high-rel; Hybrid Systems delivers. Take our tough, all-metal package: HS5200 ADC's never crack or buckle when you plug them into your PC boards or systems. And we offer the best cost-performance ratios in the business . . . because we know what that same high-rel means to our customers. Just ask your source inspectors.

Then consider this: conversion time 10uSec typical . . . ±0.002%/% power supply rejection . . . and no trimming resistors required to adjust offset and gain . . . full complement of bipolar and unipolar input ranges from ±5 to ±10V . . . with external reference models available for even higher accuracy.

For performance, experience and reliability, go with the leader.

Hybrid Systems
CORPORATION

Crosby Drive, Bedford, MA 01730
Phone (617) 275-1570
(TWX 710-326-7584 HYBRIDSYS BFRD)

In Germany: Hybrid Systems GmbH.
6100 Darmstadt, Luisenplatz 4, Germany
Tel. 6151-291595 (TELEX 419390 HYSY D)

In France: Hybrid Systems S.A.R.L.
14 Rue du Morvan SILIC 525
94633 Rungis CEDEX, France
Tel. 1-6878337 (TELEX 250969 HYSYS)

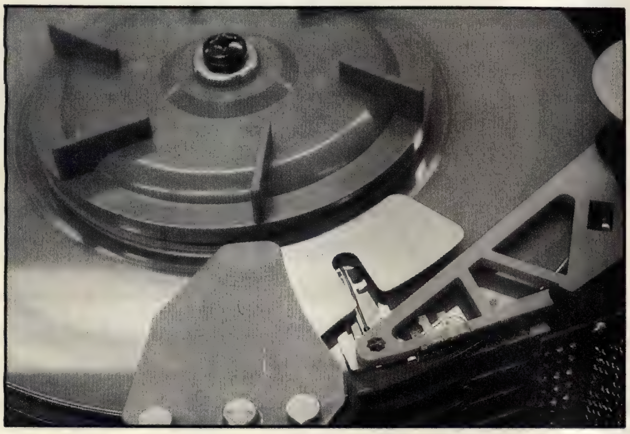
In the United Kingdom:
Hybrid (Component) Systems U.K. Ltd.
12A Park Street, Camberley, Surrey
Tel. (0276) 28128 (TELEX 858720 HYBRID G)

CIRCLE NO. 29

strategy, Memorex will offer a plug-compatible product, with features not to be found on the IBM unit. Which features? Memorex won't say.

What Memorex is doing in the plug-compatible IBM market, Dastek is attempting to do in the SMD-compatible market with its new 4835 series of thin-film, 14-in. Winchester disks. Its drive is contained in a 9.5 × 16.8 × 29.0-in. package offering 400 Mbytes of storage. (Smaller—200 and 300-Mbyte—versions will also be offered.) What's more, the 4835's price will be 20% to 35% below the going price of any currently available SMD-compatible disk drive. A user will be able to remove his present SMD drive and replace it with the Memorex, or simply add to the current capacity.

Media on the drive are the standard 3350 type supplied by Dysan (Santa Clara, CA). On the disk platter is a dedicated servo surface. The servo system uses a feed-forward generator that increases access time with the smaller, linear actuators. On the media surface, tracks are recorded at a conservative 685 bits/in., which will increase significantly, soon. Within each track, data are recorded at 12,772 bits/in., achieved in part by run-length-limited expansion code. The code helps achieve the high bit density with lower flux changes/in. than regular MFM recording.



One of the first of the new breed of 8-in. drives and a pioneer in the use of the rotary actuator, the IBM 3310 "Piccolo" uses dedicated and imbedded servomechanisms for increased data reliability.

8-in. vendors worldwide

While thin-film heads represent the breaking edge of 14-in. Winchester technology, they have not yet arrived in 8-inchers, not even in one of the first products of the 8-in. class: the IBM 3310 "Piccolo," which uses 3350-type ferrite heads and conventional ferrous-oxide media. But the 8-in. devices make up in sheer numbers of vendors what they lack in leading-edge technology. From Japan, Hitachi brings its DK801 for a first-time showing at NCC. Also from Japan, expect deliveries (finally) of the D-2200 series from NEC Information Systems (Lexington, MA). This family was first shown at NCC in 1979.

Among U.S. manufacturers getting started in the business, count Priam (San Jose, CA) with its DISKOS 2450 34-Mbyte drive (ELECTRONIC DESIGN, Dec. 6, 1979, p. 138), a 50-Mbyte product called the Cheyenne from SLI Industries (Woodland Hills, CA), and an as-yet-unspecified product from Quantum Corp. (San Jose, CA), a small company formed by a number of former Shugart Associates employees. And the year's end should see a unit competitive with the low-cost SA1000 from Shugart Associates and the Model 101 from Memorex.

Add the newcomers to the large number of companies already in the field, including IMI (the first with an 8-in. product) and BASF, both of which are currently shipping products. The IMI 7710/20 and BASF 6170 series offer a high-performance linear actuator and 10 or 20 Mbytes. Priam and its DISKOS 2050 and 3450 are in this group as well. Also competing (but not directly with these three) is Shugart Associates with its SA1000 series of low-end stepper-motor actuator drives offering 5 and 10 Mbytes. The Memorex Model 101 stepper actuator offers only a 10-Mbyte capacity and it, too, is aimed at the low-cost, higher-volume market.

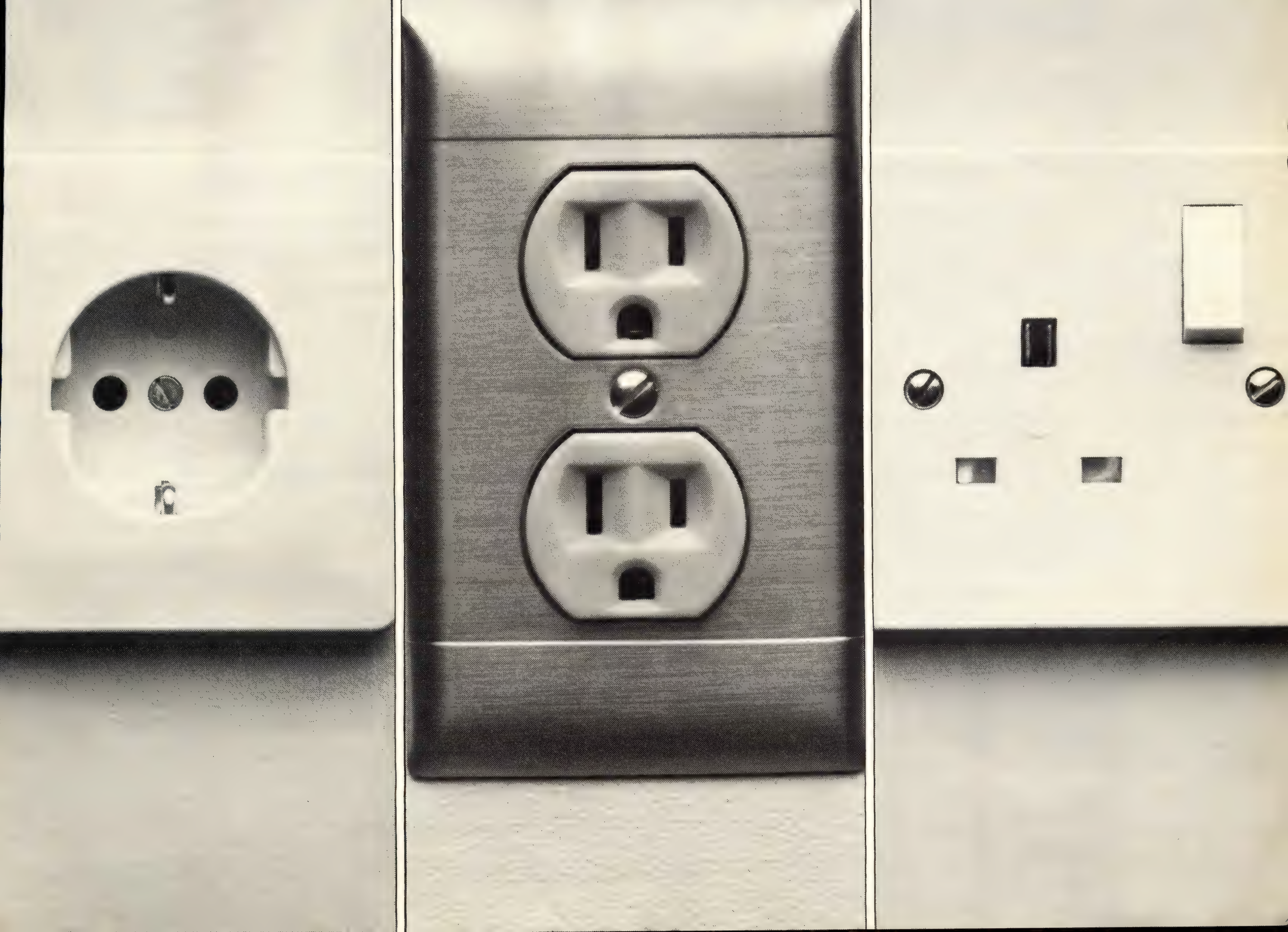
Others in the field include Kennedy with the Model 7000, Micropolis with the Micro Disk 1200, and Pertec with the D8000—drives all relying on the rotary-type positioner first incorporated in the IBM 3310 "Piccolo." As detailed by spokesman Anthony Hearn of IBM Hursley England, the rotary offers specific advantages for smaller drives. The simple bearing arrangement of the rotary actuator combined with an overall simple design results in superior reliability over the linear actuator. And because the rotary has less effective head mass, it calls for a smaller lower-power, less-expensive motor.

At capacity opposites, New World Computer Co.'s (Costa Mesa, CA) Mikro-Disc 211 comes in with a low 2.1 Mbytes, and Microcomputer Systems Corp.'s 9000 series offers 50 and 110-Mbyte drives.□

¿Puede su computadora funcionar con esto?

Kommt ir computer auch damit zurecht?

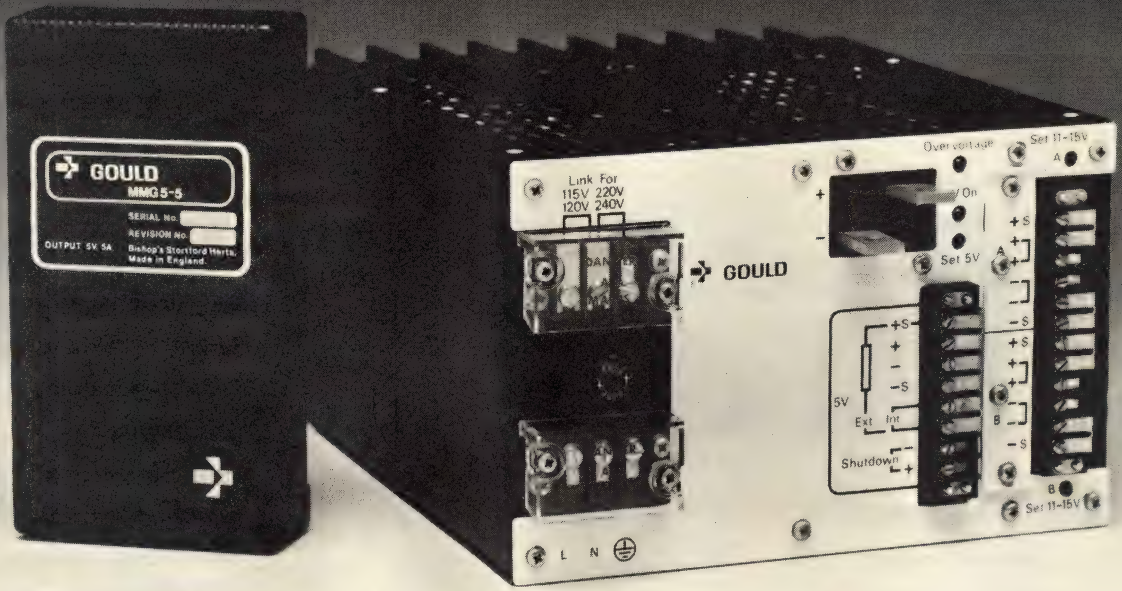
Can your computer handle these?



Gould's international team makes sure it can.

AC power poses lots of problems for the systems designer: brownouts, dropouts, high-voltage spikes and the day-to-day fluctuations in amplitude and frequency. International applications make things even tougher with voltage and frequency variations as well as new and different power supply standards.

That's why Gould, long the leading power supply manufacturer in Europe, makes so many switching power supplies for U.S. designed systems marketed internationally.



33 MG switchers that meet international standards.

West Germany's VDE defines the toughest power supply standards in the world. And all MG switchers meet both VDE0804 and VDE0875 curve N, including our miniature MGs (MMG). They also meet applicable UL, CSA, BS and CEE specifications as well as the new conducted and radiated noise limits set by parts 2 and 15 of FCC 79-555, 14686 for Class A devices.

The MG family's top-of-the-line quality and reliability have made it the leading switcher in Europe for years. Now, more and more U.S. engineers are designing it in as a solution to international marketing problems.

Gould's MG switchers handle input line voltages of 115, 220, 230 and 240 VAC, 47-440Hz. And the unique front panel input voltage selection on many models makes it easy to adapt to varying international voltages.

The MG series provides excellent protection for computers used in international applications. Each switcher features a full cycle of hold-up at 10% below nominal input and brown out protection down to 20%.

MG switchers are available in the following output/wattage combinations:

Output Voltage	Watts							
	MMG			MG				
	25	50	100	150	200	300	400	500
5	X	X	X		X	X		X
12	X	X	X					X
15	X	X	X		X			X
24	X	X	X		X	X		X
5 & ± 15				X			X	

In addition to our U.S. facility, power supply manufacturing operations in England and Germany and service facilities throughout Western Europe assure complete field back-up for the MG switcher family.

For complete specifications on Gould switchers and a copy of our short form catalog, circle the reader service number listed below or call us on our toll-free line: 800-423-4848. Gould Inc., Electronic Power Supply Division, P.O. Box 6050, El Monte CA 91731

GOULD

An Electrical/Electronics Company

CIRCLE NO. 35

The Power Paradox:

The AC power your computer needs in order to operate is also a major cause of computer error, malfunction and damage.

The computers that control your operations (and therefore your profits) are designed to operate from a clean, steady supply of ac power.

This ac power *must* be kept within manufacturer-specified tolerances in order for the computers to operate properly and safely.

In fact, the U.S. Department of Commerce states that "if a computer's voltage exceeds 120% [of the rated voltage] for a duration as short as 1 to 10 milliseconds, the computer will make errors."[1] Unfortunately, interruptions and disturbances of this nature are commonplace occurrences within most computer facilities.

A comprehensive study of power line disturbances which affect sensitive computerized equipment was conducted by two IBM researchers. They concluded that such disturbances occur on an average of 128 times each month.[2] For users of computer-based equipment, power disturbances can and do create a variety of costly problems.

Effects upon data processing computers.

When these power disturbances occur in your data processing center they can cause entry errors, program changes or loss, head crash, data loss, the generation of false or garbled data, the need to rerun programs, and computer downtime.

Effects upon computerized process control equipment.

Process control equipment is also vulnerable to power disturbances. Common problems created by these disturbances include improper batch termination and even program changes. The program changes can result in the repetition of process errors and in downtime while equipment is being reprogrammed.

Effects upon energy management systems.

Most energy management systems use small computers to make energy-saving decisions, but their effectiveness can be offset by these same disturbances. Program changes and errors may prevent useful operation of these systems as energy savers.

Thus, the computers your company depends on to reduce operating costs actually may be increasing them.

Topaz power peripherals can protect all of your computers.

Topaz can provide the power peripherals specifically designed to keep your company's data processing, process control and energy management computers from making costly power-related errors.

And if you manufacture computers or computerized equipment, Topaz peripherals can make your product more reliable as well as reduce the requirements for needless service calls.

Immediate delivery and guaranteed solutions to power problems have made Topaz the leading computer power peripheral company in the world.

For more information about Topaz and its products:

1. Tear out this ad and mail it to us along with your business card; or
2. Circle the reader service card; or
3. Call us:

Topaz peripherals solve the power paradox by conditioning normal ac power for your computer and computer-based equipment. **CIRCLE NO. 32**

TOPAZ
ELECTRONICS DIV.
3855 Ruffin Road, San Diego, CA 92123
(714) 279-0831 — TWX (910) 335-1526

References:

1. *U.S. Department of Commerce, "The Effects of Electrical Power Variation Upon Computers: an Overview."*
2. *George W. Allen and Donald Segall, IBM Systems Development Div., "Monitoring of Computer Installations for Power Line Disturbances," presented to the IEEE Power Engineering Society.*

For Solutions to Your Power Problems, Come to NCC Show Booth No. 1243/1245, May 19-22.

Health insurance for irregular voltage.

Two of the simplest, most reliable ways to keep AC line power steady and clean for sensitive electrical and electronic equipment are Sola's CVS Transformers and Solatron/Acuvolt® Line Voltage Regulators.

The CVS, a ferroresonant sinusoidal constant voltage design, blocks out brownouts and transient voltage dips or spikes. It holds output voltage within ±0.5% of nominal throughout input variations ranging to ±15%, for loads from 30 VA to 7.5 kVA.

Solatron/Acuvolt Line Voltage Regulators are solid state static-magnetic designs that combine tight regulation with fast response, adjustable output, remote sensing and high capacity, up to 750 kVA.

Both provide line-to-load isolation with no moving parts. Compact, no-maintenance construction suits industrial and marine as well as business and institutional applications.

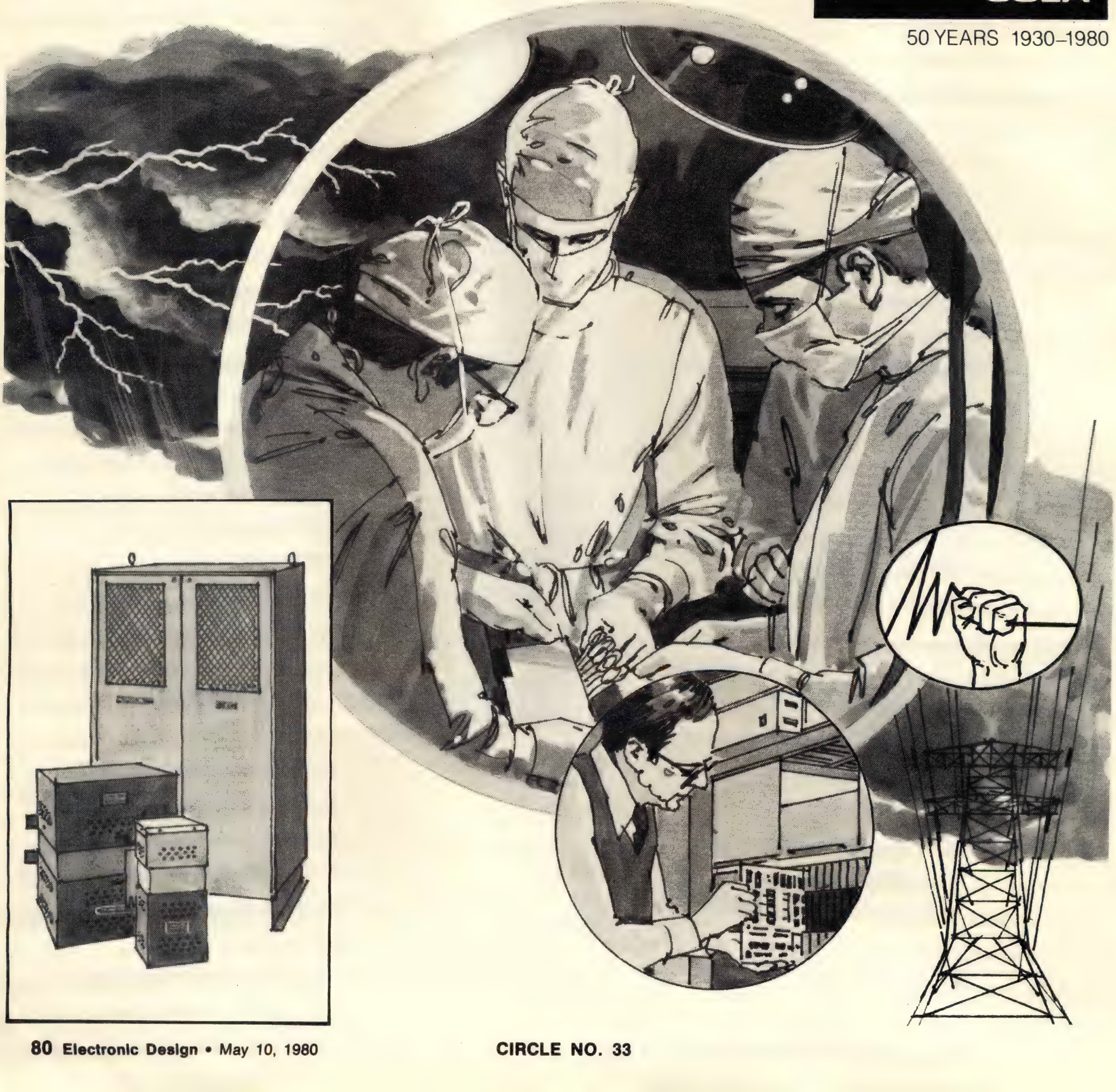
For free literature, contact Sola Electric, 1717 Busse Road, Elk Grove Village, IL 60007. Phone (312) 439-2800.

The Power Protectors

GS
A UNIT OF GENERAL SIGNAL

SOLA

50 YEARS 1930–1980



CIRCLE NO. 33

In 95 sessions, the National Computer Conference examines topics vital to designers, including computer architecture and software.

NCC '80 covers computer, processing reliability

The National Computer Conference, set for May 19 to 22 in the Anaheim Convention Center, Anaheim, CA, will comprise more than 95 sessions, covering such topics as computer architecture, data communications networks, software and distributed processing. The exhibits hall will house more than 1600 exhibits of the latest products from more than 400 companies.

Although the program is heavily oriented toward computer users, systems and subsystem designers will unearth many nuggets of valuable design information.

At the same time that throughput, processing speed and flexibility remain strong priorities, the issue of reliability has grown in importance in all three areas: New protocols are reducing data comm errors, languages are becoming more readable and programmable, and LSI modules are helping to ensure the reliability of very large systems.

Max Schindler, Software Editor
Len Yencharis, Computers Editor

CCITT, IBM and Compression Labs, among others, are working to standardize facsimile transmissions. In November 1980, in Geneva, the CCITT study group will complete its new standards for two-dimensional facsimile transmission. The CCITT recommendations, T.4 and T.30, cover the protocol and handshaking procedures for facsimile transmission over the General Switched Telephone Network (GSTN). T. L. McCullough (3M Co., St. Paul, MN) relates these proposals to simplex, half-duplex and full-duplex configurations.

Joan L. Mitchell (IBM, Yorktown Heights, NY), compares CCITT's recommended two-dimension Modified Relative Address Designate (Modified READ) and IBM's recommended coding scheme. The modified READ code uses vertical reference coding out to ±3 picture elements (PEL); IBM concentrates on vertical transitions within only 1 PEL.

Table 1. FCC-licensed services approved for data

Name of service	Transmission mode	Defining FCC regulations	Service frequency range	Bandwidth authorized for data	Normal reception range
Subsidiary Communications Authorization (SCA)	Broadcast	73.310	88 to 108 MHZ	22 kHZ (assumes stereo main channel)	100 miles (class C station)
Radio Common Carrier (RCC)	Point-to-point	21.509 (e)[1,2]	158 and 454 MHZ	2 kHZ	Up to 100 miles
Domestic Public Land Mobile Radio Service (DPLMRS)	Broadcast and point-to-point	21.509 (e)[1,2]	470 to 512 MHZ	3 kHZ	Up to 100 miles
Multipoint Distribution Service (MDS)	Broadcast and point-to-point	21.503 (a) and (b)	2150 to 2162 MHZ	6 MHZ	Line of sight

1. The means used by the FCC in determining the nature of a communications application is the user's intent:
   A. Broadcast alone implies not point-to-point and usually implies public service.
   B. Point-to-point alone implies not broadcast.
2. The user is not required to obtain FCC licensing because the transmission service operator has already done so.

The author also addresses the future, when transmissions will be sent in uncompressed modes. These modes can improve compression for images employing many 1 or 2-PEL runs.

Another new proposal for bandwidth compression of facsimile data is Combined Symbol Matching (CSM). As described by Patrice J. Capitant and Robert H. Wallis (Compression Labs, Cupertino, CA), CSM is a dual-mode encoding system for optical character recognition (see Fig. 1). It is based on the detection of recurrent patterns (for example, alphanumeric characters) in the document being transmitted. The speakers compare this encoding technique to both symbol matching and facsimile operational modes. In a special test of 1000 samples with identical sets of symbols, the CSM algorithms rejected all damaged characters and no mismatches were reported.

A new system for rf communications combines existing radio-broadcasting techniques with a digital modem to achieve digital broadcasting. The result, according to Thomas G. Albright and Robert J. Wallace (Printer Terminal Communications Corp., Ramona, CA), is a local rf voice-grade data channel that provides a regulated signal to the broadcast operator.

The Local Area Data Distribution (LADD) system comprises a physical link between the facility of the FCC licensed-operator and the data communications network (see Table 1); a controlling-site processor that takes in the data and regulates the flow of addressed messages; and a broadcasting system. In addition to serving as an arbitration device, the processor can invoke special messages on a message-by-message basis.

The information bit error rate of a properly tuned LADD system is less than 10^{-7}. This rate can be improved by utilizing link-forward error correction (FEC) routines. However, error-checking and correcting routines, though they improve accuracy, also reduce the maximum transfer rate of the broadcast channel.

In many LADD systems, error checking and correction may not be necessary, because a 10^{-7} error rate is already better than that of common carrier links. These links typically offer bit-error rates between 5×10^{-5} and 5×10^{-6}.

Transmission protocols cut errors

The data link control (DLC) frame is another procedure for transferring data packets across noisy transmission mediums. The error rate, according to Martin Reed (IBM, Gaithersburg, MD) and Terence D. Smetanka (IBM, Research Triangle Park, NC) reflects the noise characteristics of power amplifiers as well as line conditioning, which can lead to the receiver obtaining a garbled message.

To overcome the error rate problems, systems network architecture (SNA) employs synchronous data link control (SDLC), a subset of the International Standards Organizations High-Level Data Link Control (HDLC) and ANSI's Advanced Data Communications Control Procedure (ADCCP). A message consists of one or more SDLC frames, which contain up to six fields. All the fields, except the information field, are fixed in size. The information field has a variable number of 8-bit bytes.

Two flags (01111110) enclose the SDLC frame.

Table 2. Line protocol features and characteristics

Feature	Bisync	DDCMP	ADCCP	HDLC	SDLC
Protocol type (i.e., data transparency)	Chracter stuffing	Count	Bit stuffing	Bit stuffing	Bit stuffing
Full duplex	No (HD)	Yes	Yes	Yes	Yes
Serial	Yes	Yes	Yes	Yes	Yes
Parallel	No	Yes	No	No	No
Multiacknowledge by one ACK	No	Yes	Yes	Yes	Yes
Asynchronous operation	No	Yes	No	No	No
Point-to-point	Yes	Yes	Yes	Yes	Yes
Multipoint	Yes	Yes	Yes	Yes	Yes
Error detection (CRC)	CRC-16	CRC-16	CRC-CCITT	CRC-CCITT	CRC-CCITT
Retransmit error recovery	Yes	Yes	Yes	Yes	Yes
Count field required	No	Yes	No	No	No
Protocol overhead (single data message)	80 bits & DLE additions	80 bits	48 bits fixed & ZEROS for bit stuffing	48 bits fixed & ZEROS for bit stuffing	48 bits fixed & ZEROS for bit stuffing

Only the two flags may have six contiguous ONES. The SDLC procedures assure data transparency by requiring that the transmitter insert a binary ZERO after any succession of five contiguous ONEs in the frame. The receiver removes the inserted ZEROS when it receives the frame.

A 16-bit frame check sequence field is used in a cyclic redundancy check to determine if the frame was received correctly.

The response time for interactive applications in a noisy telecommunications link is analyzed by a technique called automatic request for repeat (ARQ). This model, the authors claim, can define many software and hardware parameters affecting the planning, design and cost/performance requirements of an SNA system.

Whither mini networks?

Comparisons of 16 minicomputer networks by Douglas A. Theis (Aerospace Corp., El Segundo, CA) clarifys the tradeoffs in choosing HDLC, SDLC and other network and line protocols (see Table 2), hardware interfaces and software segments. Theis anticipates more support and implementation for distributed network and multiprocessing architectures. In distributed networks, integral microcomputers will take over line protocol functions to reduce software overhead.

In business operations, distributed network systems will use remote nodes to feed a hierarchy or centralized node that processes data, fills orders, updates inventory and provides many other functions. Shared disk systems will be used less often for such pure multiprocessing, despite their high reliability, and more often for large data base applications.

Another type of multiprocessing architecture uses a high-speed bus to provide automatic failsafe. This alternative to large-scale single computers is less expensive and can operate without the support of system programmers.

PLAIN speaking in programming

Despite the different requirements of applications programmers, the languages they use have more simularities than differences. They have all been designed with the objectives of modularity, readability, reliability and moderate size.

Two new languages (PLAIN and Conlan) and two new approaches to Pascal attempt to overcome the shortcomings of older languages in these objectives. The Programming Language for Interaction (PLAIN), presented by Anthony I. Wasserman (University of California, San Francisco), contains several features that assist the development of programs involving conversational access to a data base and its resources:

- A data-type STRING, of variable length, together with appropriate operators and functions for string manipulation.
- Pattern-matching operations, both for validating user input and for formatting input and output
- A data-type RELATION to manage relational data bases
- A procedure-oriented exception-handling mechanism for trapping errors and restricting control flow, mostly in the event of user input errors.

The goal of brevity in PLAIN was somewhat sacrificed to other needs in the application area. Most differences between Pascal and PLAIN lie in PLAIN's superior support of abstraction and modularity.

Pascal has several major weaknesses: Programs are free to access and modify global variables with a lexical content, so considerable code inspection is required to determine the exact data flow. Access to dynamic structures via globally-declared pointers can also create "dangling references." Modules lack input/output parameters, since parameters in Pascal are passed by value and by reference—an implementation rather than a programming concept. Furthermore, although Pascal supports procedures and functions, it has no facility for defining types of encapsulated data. Pascal functions may accept parameters by reference and modify them internally; functions may also make an assignment to a global variable. Thus, the mathematical concept of a function is violated and new output parameters can be created in the function module.

PLAIN attempts to correct each of these weaknesses. Like Ada, PLAIN overcomes the dangling reference problem by forbidding deallocation of dynamically allocated variables. The use of pointer-type objects is restricted in PLAIN to limit the number of program units that are aware of the representation of dynamically allocated objects.

PLAIN contains a facility for encapsulation, which is similar to the facilities in CLU, Euclid and Ada. To disallow side effects in functions, PLAIN prohibits importing and modifying globals and using read-only globals or parameters as modified parameters within the function. Since the syntax of PLAIN forbids modified parameters, aliasing cannot cause side effects.

The PLAIN exception-handling mechanism sustains a well-structured flow of control. The programmer may create a handler procedure for a specific exception at a specific program location. This procedure carries out any required actions, clears the offending exception and then returns control to the normal program flow.

PLAIN is presently being implemented on the

PDP-11 computer under the UNIX operating system and should be operational early in 1980.

Authors affiliated with one French University, three American Universities and Honeywell Corp. discuss another new language, Conlan, at a session chaired by Robert Piloty (Technical University, Darmstadt, Germany).

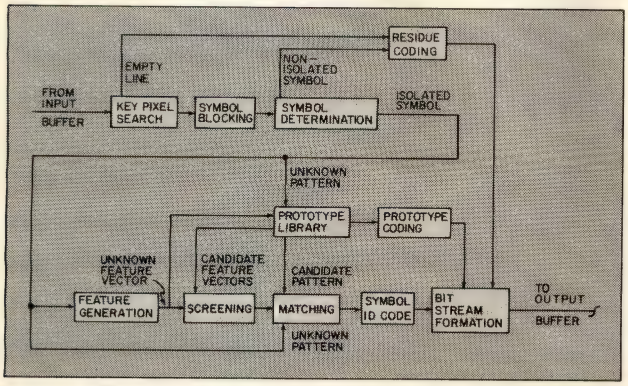
Conlan (consensus language) is meant for a select group of engineers, namely, logic designers. The Conlan Working Group was formed in 1973, to develop a broadbased hardware design language (HDL) from the several dozen HDLs in existence.

One root language, called base Conlan (bcl) serves as the interface between the Conlan Working Group and its two categories of "consumers": Toolmakers who use bcl to construct languages and associated CAD tools and users who write hardware-system descriptions in these languages.

Base Conlan is primarily a starting point, with well-defined and semantically sound primitives. As a result, hardware descriptions in bcl look verbose. More time and effort will be needed before user-oriented, less general, but simpler, special-purpose languages are developed.

Nevertheless, base Conlan contains all the concepts pertinent to hardware modeling. A design can be partitioned into a network of interconnected modules by description segments, which directly depict the structure of a system, and by data and control paths, which connect the system components. Conlan also provides function and activity segments, to describe the behaviour of a system, often in a more concise manner than when the full structure is displayed.

Mark Overguard (Softech Microsystems, San Diego, CA) discusses the UCSD form of Pascal, which is used mostly in small computers. The foundation of the UCSD Pascal System is the p-machine. The entire Pascal system (including editors, compilers and operating system) can be moved to a new host computer by reimplementing the p-machine and associated low-level routines in the native language of the new host. The relatively simple implementation has been exploited in more than a dozen microprocessors and minicomputers. Implementation requires from 1.5 to 9 man-months, depending on the experience of the implementor and the suitability of the host for p-machine implementation.



1. In a CMS encoded system, scan lines of binary image data are stored in a scrolled buffer and examined to detect black pixels. If a scan line does not contain a black pixel, the information is encoded by an end-of-line code. The number of scan lines equals two to six times the average character height.

UCSD p-code is portable at the binary code file level, making it a practical "lingua franca" for communicating object programs in a wide user community. Even though the p-machine is optimized for Pascal programs, translators can be and have been written from Basic and Fortran to p-code.

Pascal crossfire

The limitations of Pascal have also been tackled by the Naval Ocean Systems Center (NOSC). According to G.G. Gustafson et al. (Computer Sciences Corp., San Diego, CA), NOSC initiated the BIODAB project in 1976 to determine if a high-performance, relational, data-base management system could be developed to support scientific applications.

Initially, the BIODAB prototype was implemented in Fortran V, with less than 10% assembly language. But Pascal was used for much of the later software expansion because there is little interaction between the old and new code. Presently, 23,000 lines are in Fortran (generated by the Formel "structured Fortran" preprocessor), 3200 lines are in assembly language and 18,300 lines are in Pascal.

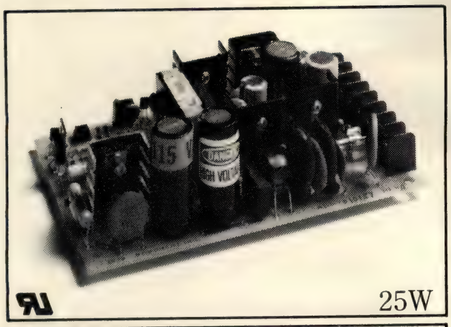
The programming team encountered two categories of problems using Pascal in a production environment. One category involved the language definition itself, and the other was associated with the specific language implementation used.

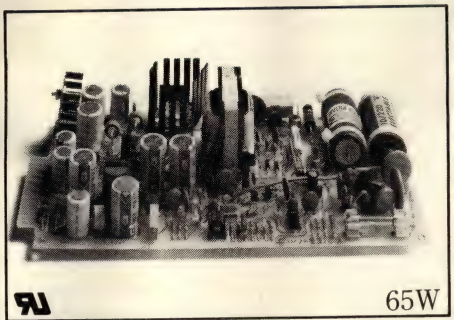
In a multilanguage environment, Pascal does not define the mechanism for independent external compilations of modules. In large-scale software development, as many as five programmers may have to edit the same workspace simultaneously. Therefore, modules should be developed independently and tied together through mechanisms offered by the operating system or system processors.

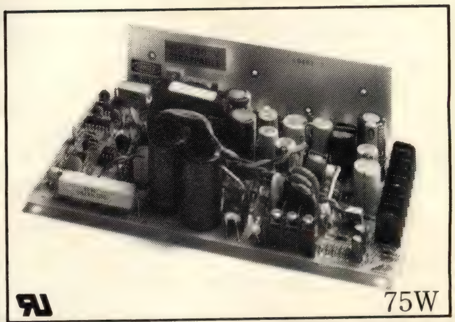
Complex systems also frequently require the collection of programs into separately addressable banks. This technique, known as "bank-named collection," minimizes core-use charges by switching out the banks which are not required.

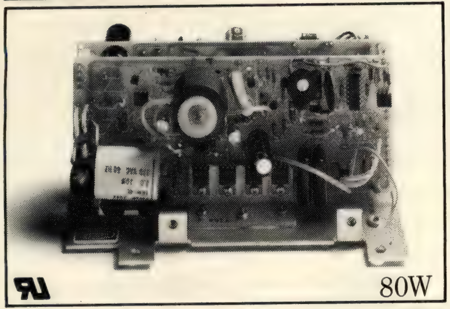
Fortran handles switched-bank communication through the COMMON statement. A named COMMON

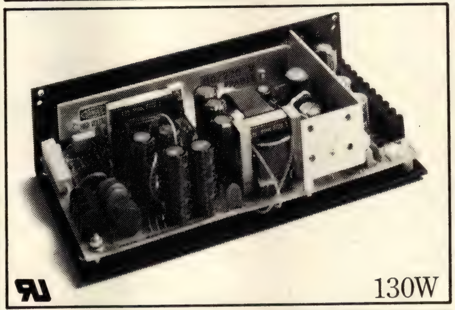
People are switching to Boschert

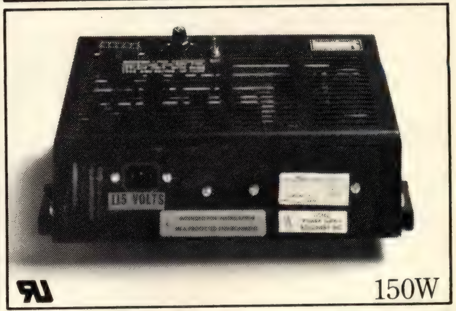

25W

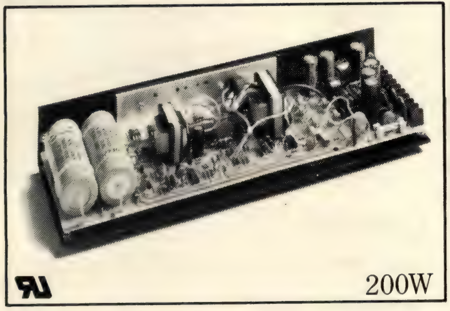

65W

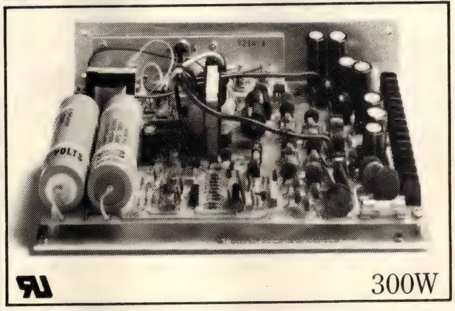

75W

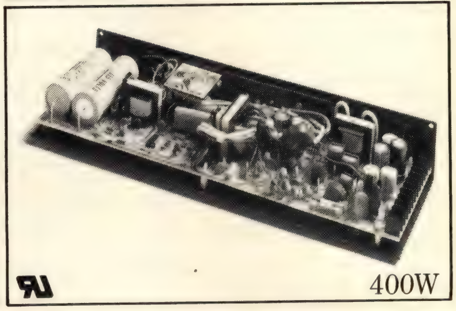

80W


130W


150W


200W


300W


400W

because only Boschert offers a complete line of 25-400 watt switching power supplies.

When you want power, come to Boschert. We're the power leader with more standard 25-400 watt switching power supplies in production and in stock than any other manufacturer. Every one is UL-recognized. Each meets international input voltage requirements. And we offer the multiple output voltages you need to meet your particular system requirements.

Plus, when you switch to Boschert, you enjoy advantages only a leader can offer. Like high volume automated production capabilities to support your volume requirements. Off-the-shelf delivery when you need product fast. Custom tailoring. An up-to-date understanding of VDE requirements. Boschert even offers you an extensive European distribution network to support you overseas.

At Boschert we've been building off-line switching power supplies for almost a decade. Over 200,000 of our multiple output power systems are now in operation. Isn't it time you made the switch to Boschert?

For more information on our full line of switching power supplies, contact your local Boschert representative, or write: Boschert Inc., 384 Santa Trinita Ave., Sunnyvale, CA 94086. Or call us direct, (408) 732-2440.

powered by boschert

See us at NCC at Booth #2659-61

is placed in a control bank (i.e., one that would not be switched out), and any Fortran module can add updates to it. This feature is particularly useful in maintaining the status of a bank that was executed earlier but is no longer active. Although designers are able to work around this problem, they need a Pascal equivalent to Fortran's COMMON.

Advocates of Pascal frequently assert that Pascal programs are portable. However, Pascal does not allow the programmer to define constants, particularly parameterizing constants, in terms of previously declared constants. The programmer has to write

```
PI=3.1415926;
TWOPI=6.28318531;
```

rather than

```
TWOPI=2.0 * PI;
```

One of the more annoying problems in debugging a Pascal program is caused by the lack of a comment terminator "*)". If the compiler ignores the balance of the code, voluminous messages are produced at the end of the listing. The end of a source line should act as a comment terminator.

As an aid to producing structured code, the syntax of the Pascal FOR statement should be modified. The contrivances needed for step values other than 1 in the loop control-variable negate one of Pascal's more important design goals: a systematic discipline based upon certain fundamental concepts clearly and naturally reflected by the language. Recomputation of a pseudo loop variable within the body of a loop is not consistent with a natural or clear language.

The functions provided for numerical analysis in Pascal are simply inadequate in the production environment—Fortran's instrinsic functions are important in scientific programming. The need to develop these functions during a production project raises the possibility of accuracy and precision errors.

Finally, the I/O facilities of Pascal require major revision and redesign. Data types, other than the standard types, cannot be displayed directly. For example, an integer cannot be displayed in octal form. These difficulties have a direct effect upon the work required to debug programs.

After adjusting productivity rates for Pascal and Formel code to account for coding conventions or preprocessor use, programming teams were able to produce 50 lines of Pascal per programmer day and 86 lines of Formel. The original BIODAB project (90% of the code in Fortran without a preprocessor) produced 45 lines of source code per programmer day.

Designers of supermainframes must aim for contradictory goals: a system designed with enormous complexity, yet with a high level of reliability. At NCC, such advanced systems receive the title of Supersystems from Svetlana and Steven Kartashev of the University of Nebraska (Lincoln, NE) and Dynamic Computer Architecture Inc.

To increase throughout in a complex parallel system, the designer may draw upon several traditional approaches: faster hardware; modular expansion with new equipment; specialized architecture; special computations (pipeline, array, associative); and optimizations of data exchanges between separate computers or processors. Each step forward in throughput, however, may entail a step backward in reliability.

Supersystems aim high

Some system components may be replaced with faster ones during a system's life but massive online replacements with newer and faster units is impractical. Many leading-edge components become obsolete anyway, by the time system development is complete. Modular expansion is also of limited value since additional hardware requires additional connections. Too much expansion with new hardware could compromise the system's diagnostics.

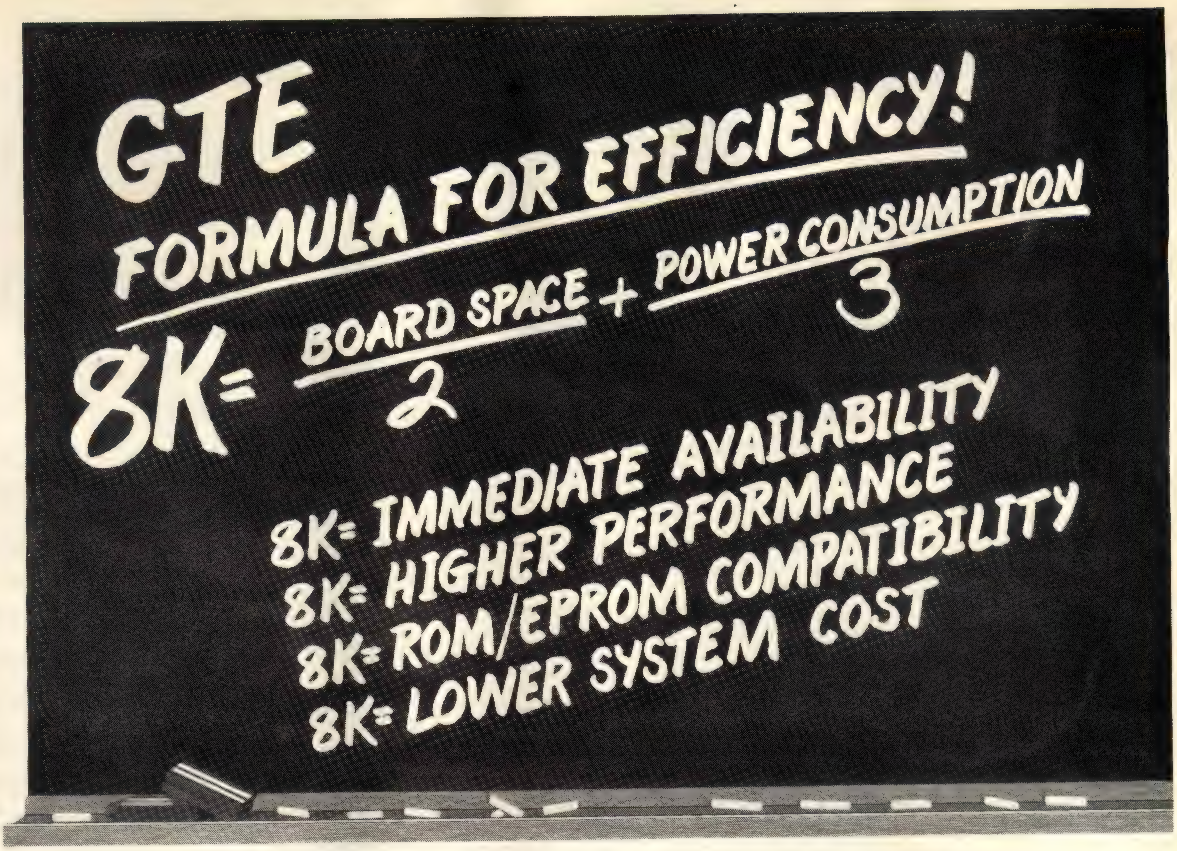
With dedicated architecture, special-purpose micro-operations and dedicated instructions facilitate the execution of an algorithm. However, dedicated architecture reduces the system's flexibility in handling a new problem or modifications of an old problem.

Special architectures (like pipelining or associative processing) require a separate subsystem for each task in a complex algorithm; the result is an excessively complex resource. Each subsystem engages in only one task; and while one system is working, all the others are idle.

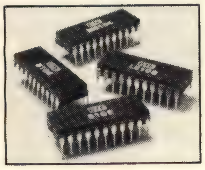
For Supersystems, the path to increased throughput lies elsewhere—in LSI modules which become the building blocks of a system. Through advances in LSI technology, these modules offer high computational throughput. Each module is equipped with simple circuits that activate and deactivate its connection with other modules, under software control.

For instance, processor modules can switch among several main memory modules, to speed up processor-memory communications. Or, one processor can be reconfigured into several smaller processors in an array parallel system.

Through dynamic redistribution of available hardware, the numbers and sizes of computers in a system can be altered, to adjust the computer architecture according to the number of information streams in complex algorithms. Thus, a computer assembled from LSI modules adapts better than traditional systems to executing algorithms.


GTE
FORMULA FOR EFFICIENCY!
8K= BOARD SPACE / 2 + POWER CONSUMPTION / 3
8K= IMMEDIATE AVAILABILITY
8K= HIGHER PERFORMANCE
8K= ROM/EPROM COMPATIBILITY
8K= LOWER SYSTEM COST

That's right! If you're still using 1K or 4K Static RAMs . . . you're wasting valuable board real estate and using too much power.



But never worry . . . GTE's 8K Static RAMs allow you to reduce board space by 1/2 and power consumption by 2/3.

Anyway you measure it, that's a formula for efficiency!

When GTE Microcircuits talks about 8K Static RAMs, people listen. The reason...because we're talking about a family of standard products that are *available NOW!* In fact, GTE's proven 8K process technology (based on 5 years of 2114 production experience) not only offers significant power savings, but guarantees ultimate reliability and lower system cost...plus the convenience of an 8-bit bus I/O structure. And what's more, GTE's 8K is the only Static RAM with an announced second source.

Furthermore, our 8K Static RAMs are available in a variety of configurations to meet the needs of your most demanding application. You can select from a range of access times...you can have a delatched write function for microprocessor applications...you can order special low power devices...or, for your long-haul, high reliability needs, there's a military version that meets MIL-STD-833 requirements.

Delivery? It's simple...we offer immediate factory delivery of all configurations. Our distributors can deliver right off the shelf.

Anyway you measure it, GTE 8K Static RAMs will provide you a proven formula for memory efficiency.

Increase your memory efficiency by calling Toll Free for the name of your local distributor and a copy of our new Short Form catalog. Call today!

Call Toll Free 800-528-6050

8K Static RAMs

GTE **Microcircuits**

2000 West 14th Street
Tempe, Arizona 85281
(602)968-4431
TWX: 910-951-1383

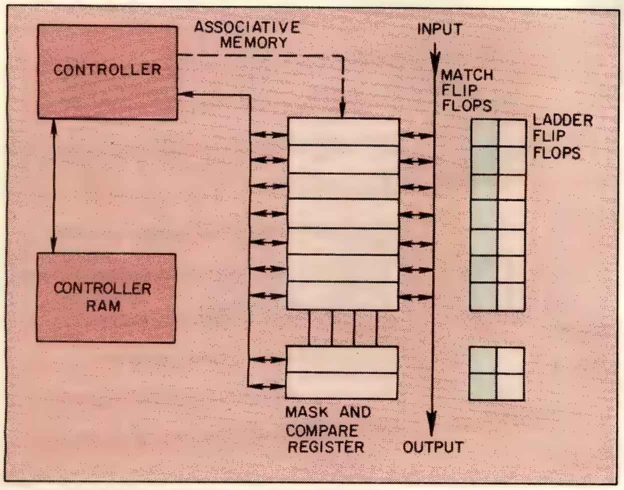
CIRCLE NO. 31

Architectural research has concentrated on pipelining to augment this throughput. A dynamic pipeline for a Supersystem can be assembled from the same LSI building blocks and with the same methods that are used for multicomputer, multiprocessor and array systems with dynamic architectures.

The increased throughput that the LSI modules promise is realized by Universal Dynamic Computer Groups. Each UDC group assembles computer elements, a reconfigurable memory-processor bus and a monitor equipped with memory into a computer of almost any size. Each computer element—comprising one processor element, one memory element and one I/O with elementary memory—processes 16-bit words in parallel. The assembled computer can contain from one to "n" number of computer elements; consequently, its word size can expand in 16-bit increments up to 16n-bits. Dynamic architecture partitions the hardware resource into 16, 32 and 48-bit or larger computers.

The reconfigurable memory-processor bus contains address-connecting elements (ASE) and memory-connecting elements. The ASE connect the processor elements with the memory elements, and broadcast memory address and read and write signals from each processor element to all the memory elements. The designer must establish an address path and a data path to carry the communications.

The Kartashevs show that a Supersystem with dynamic architecture gives better performance if the UDC groups are reconfigured into very small computers. A maximum number of programs can be computed by one group, and computations are completed faster by switching the groups into different types of architecture—array, pipeline, multicomputer/multiprocessor. Thus, the available resources are never idle even when the computations require dedicated subsystems.



2. An associative processor is practically the reverse of the usual CPU: All memory locations are searched simultaneously and a match sets flags.

Hubert H. Love (Hughes Aircraft) explores two very different architectures for supercomputers: the associative processor and the massively parallel processor.

The associative processor is an unusual type of reconfigurable array system. In a sense, its basic operating principle is the reverse of that for a serial processor. The associative processor is based on a "search memory." Unlike a RAM—which accepts the address of a memory location as input and outputs the contents of the location—the search memory accepts the contents of the memory as input and outputs flag settings to indicate the location.

Associative memory is an extension of search memory. It operates on the same search-by-content principle but contains additional logic at each cell, performing word-parallel logical, arithmetic, input and output operations, generally in bit-serial fashion. Among the logical functions typically offered by associative memory is a parallel-write operation. It simultaneously modifies selected bit positions at all cells in the associative memory or throughout a selected subset of the cells. The bit positions to be modified are determined by the contents of the mask register; the cells to be modified are selected by the settings of the match flip-flops. The changes to bit positions are set in a compare register and are the same for all selected cells.

Parallel arithmetic operations are generally implemented through special arithmetic logic, including a full adder at every cell. One adder contains all the data for one cell. Fig. 2 shows the organization of a typical associative processor.

Associative processor

As an example, the Associative Linear Array Processor (ALAP) has been used for radar signal sorting, radar track-while-scan tasks and generalized data-retrieval from a structured data base. It is particularly suited to tasks in which many diverse parallel operations take place simultaneously within the same memory array.

Another design for Supersystems is the massively parallel processor (MPP). It consists of cells organized into a two-dimensional array by the communication network. Each cell communicates directly with its four nearest neighbors, and can perform arithmetic and logical operations simultaneously with all other cells. One operand resides in each cell, and the other can reside in the same cell, in another cell or on a common bus.

The square array organization is well suited to the MPP's main use, the processing of satellite image data, which requires 100 to 10,000 operations per pixel. ☐

MICROSOFT. NOBODY DOES IT BETTER.

In 1975, Microsoft wrote the first BASIC interpreter for the 8080. Today, hundreds of thousands of microcomputers run with Microsoft software. And tomorrow—a full line of system software for the 8086 and Z8000. With microcomputer software, nobody does it better.

BASIC Compiler Microsoft's BASIC compiler is the ideal software tool for the development of BASIC applications programs for resale. Compiled object code for any application may be distributed to your customers on diskette or ROM, thus safeguarding the source program. And execution speeds with our compiled BASIC code are faster than with any other BASIC. Highly optimized, compact object code means maximum efficiency in any application. The BASIC Compiler supports all the language features of our BASIC-80 Interpreter. Comes with macro assembler and loader. Runs with CP/M, ISIS-II, TRSDOS. $395.

BASIC Interpreters for 8080, Z80, 8086, 6800, 6809 Language features above and beyond any other BASIC have made Microsoft's BASIC the world's most popular interpreter. And now three new versions are available for the 8086, 6800, and 6809. The latest releases of BASIC-80 and BASIC-86 support the new WHILE conditional, plus CHAINing of programs with COMMON variables, dynamic string space allocation and variable length records in random files. All versions have double precision arithmetic, full PRINT USING, tracing, renumbering, edit mode, and many other features. BASIC-80 for CP/M, ISIS-II, TEKDOS: $350. BASIC-86 standalone on SBC 86/12: $600. BASIC-68 for FLEX: $200. BASIC-69 for FLEX: $250.

COBOL-80 Compiler The best implementation of the world's most widely used programming language is COBOL-80 from Microsoft. As small business applications become not-so-small, COBOL-80 is ready with powerful use of disk files, data manipulation facilities, CHAIN, segmentation and interactive ACCEPT/DISPLAY. Plus three-dimensional arrays, full COPY facility, indexed and relative files and an optional packed decimal format that saves on mass storage by as much as 40%. Comes with macro assembler and loader. Runs on CP/M, ISIS-II, and TRSDOS. $750.

NEW! muSIMP/muMATH-79 At last, a sophisticated math package for microcomputers. muMATH performs mathematical operations efficiently and accurately. Use it to solve equations and simplify formulas; or perform exact arithmetic, symbolic integration and differentiation, infinite precision integer arithmetic and symbolic matrix inversion. muMATH is an invaluable tool for engineering and scientific applications involving lengthy, analytical computations. It is also an ingenious teaching method for all levels of math from arithmetic to calculus. muMATH is implemented in muSIMP, a highly structured language for complex symbolic manipulations. muSIMP/muMATH Package, CP/M versions: $250.

NEW! muLISP-79 LISP—the lingua franca of the artificial intelligence world—is now available in this efficient, low-cost version for microcomputers. Features include dynamic allocation of storage resources; program control structures such as an extended COND and a multiple exit LOOP; user functions defined as CALL by Value or CALL by Name; and 83 LISP functions. muLISP-79, CP/M version: $200.

NEW! XMACRO-86 For the development of 8086 programs, our new XMACRO-86 cross assembler has just been released. It supports the same features as our MACRO-80 assembler. Develop 8086 programs now on your current CP/M, ISIS-II, or TEKDOS system. $300.

NEW! Micro-SEED DBMS If you are developing applications software in-house or bundling hardware and software for resale, a database manager could be the software tool you've been looking for. Micro-SEED is the first CODASYL compatible database management system to run with CP/M; and Microsoft's FORTRAN-80 has been implemented as the host language. When an application becomes limited by traditional floppy disk file handling, but remains overpowered by the cost and maintenance of a minicomputer, the solution is Micro-SEED. $900.

FORTRAN-80 Compiler Microsoft FORTRAN-80 is the most complete microcomputer FORTRAN available. It has all of ANSI-66 FORTRAN (except COMPLEX data), plus unique enhancements for use in the microcomputer environment. An extensive library of single and double precision scientific functions, too. Comes with macro assembler and loader. Versions for CP/M, ISIS-II, TEKDOS. $500.

MACRO-80 Assembler The most powerful microcomputer assembler on the market today is Microsoft's MACRO-80. It is fast, and it supports Intel-standard macros, relocation pseudo-ops, conditionals and listing controls. MACRO-80 comes with a relocatable linking loader and runs with CP/M, ISIS-II, and TEKDOS. $200.

EDIT-80 Text Editor Random access to floppy disk files makes EDIT-80 the fastest microcomputer text editor. It's the essential tool for creating and maintaining all files. EDIT-80 includes FILCOM, a file compare utility. EDIT-80, CP/M version: $120.

Prices quoted are USA domestic only. OEMs should contact Microsoft for prices.

OS ➤ MICROSOFT ▼	CP/M	ISIS-II	TRSDOS	TRSDOS Md II	TEKDOS
BASIC-80 INTERPRETER	●	●	■	■	●
BASIC COMPILER	●	●	□	●	
FORTRAN-80 COMPILER	●	●	□	■	●
COBOL-80 COMPILER	●	●		●	
muMATH/muSIMP muLISP	●		□		
MICROSEED DBMS	●				
EDIT-80 TEXT EDITOR	●		□	■	
MACRO-80 ASSEMBLER	●	●	□	■	●

● contact Microsoft ■ contact Manufacturer
□ contact Microsoft Consumer Products

MICROSOFT

ASCII MICROSOFT
102 Plesarda
3-16-14 Minami Aoyama
Minato-ku
Tokoyo 107, Japan
03-403-2120
Telex 2426875ASCIIJ

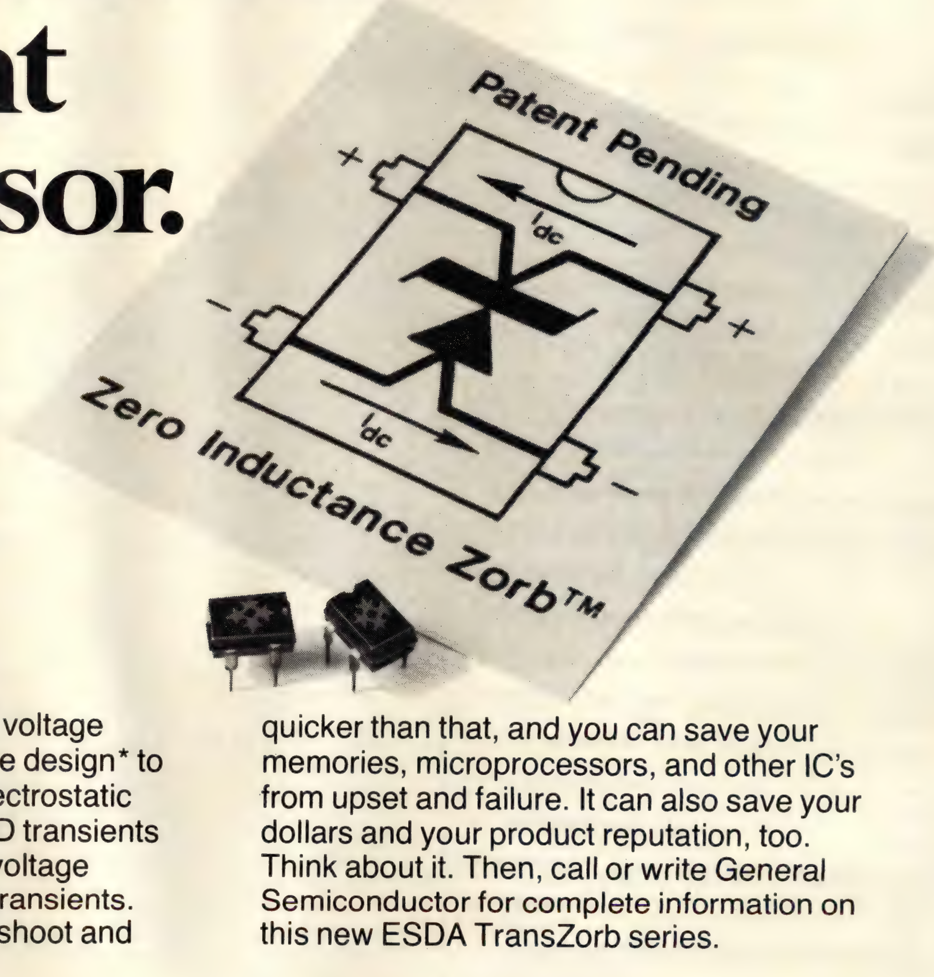
VECTOR MICROSOFT
Research Park
B3030 Leuven
Belgium
(016) 20.24.96
Telex 26202 VECTOR

We set the standard.

CIRCLE NO. 169

For exceptional ESD circuit protection.

Meet the New Zero Inductance transient suppressor.



This all new TransZorb® transient voltage suppressor uses a zero inductance design* to protect integrated circuits from Electrostatic Discharge (ESD). It will clamp ESD transients and stop the inductive overshoot voltage caused by nanosecond rise-time transients. Zero inductance means zero overshoot and lower clamping.

ESD is characterized by rise-times of 2 Kilovolts per nanosecond and peak current of 40 Amps at 20,000 Volts. The new Zorb™ is quicker than that, and you can save your memories, microprocessors, and other IC's from upset and failure. It can also save your dollars and your product reputation, too. Think about it. Then, call or write General Semiconductor for complete information on this new ESDA TransZorb series.

*Patent Pending

TransZorb® is a registered trademark of General Semiconductor Industries, Inc.

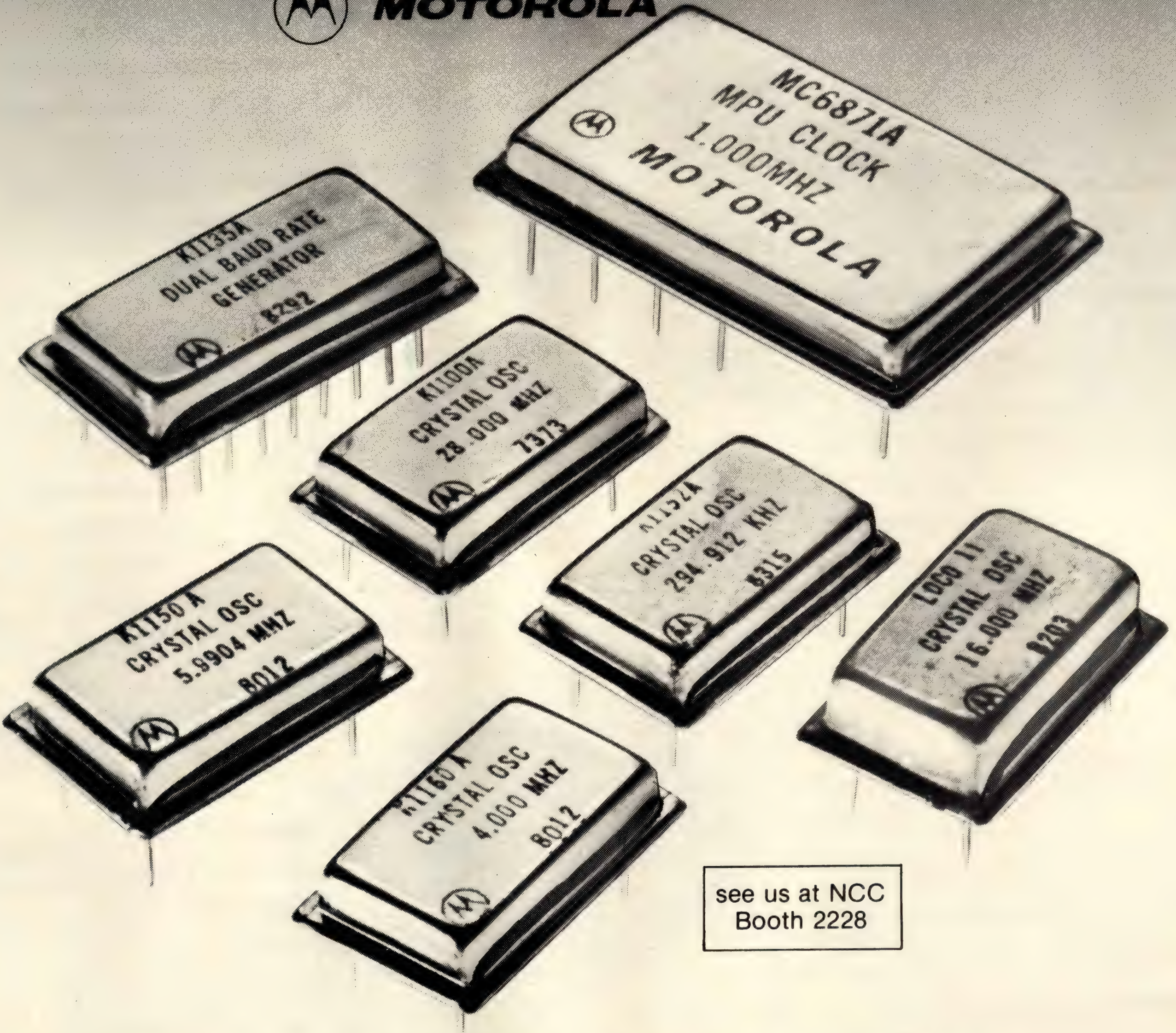
Zorb ™ is a registered trademark of General Semiconductor Industries, Inc.

GENERAL
SEMICONDUCTOR
INDUSTRIES, INC.

2001 West Tenth Place • P.O. Box 3078 • Tempe, Arizona 85281 • 602-968-3101 • TWX 910-950-1942

CIRCLE NO. 30

Crystal Clock Oscillators by MOTOROLA



see us at NCC
Booth 2228

...the timing standard of the computer industry

The widest selection of thick film hybrid oscillators available anywhere for computer and microprocessor applications. Logic outputs are available for TTL, CMOS, NMOS, and dual complementary TTL.

Frequencies as low as 25 KHz, and as high as 70 MHz. High stability when you need it, tolerance tradeoffs for applications in which economy is more important.

Complete in-house control, from quartz growing through thick-film processing enhances reliability.

High volume production capability plus fast prototype delivery helps you meet your own delivery requirements.

DIP packaging saves board space, cuts assembly time over discrete component equivalent. Simply plug a Motorola Clock into your circuit to satisfy all your system timing requirements.

Send today for more information on the clock oscillator to fit your application.

MOTOROLA INC.

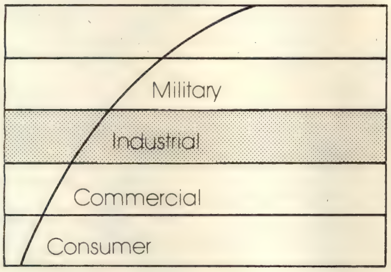
Component Products / 2553 N. Edgington Street / Franklin Park, IL 60131 / 312/451-1000 TWX: 910-227-0799 Telex: 025-4400

CIRCLE NO. 37

ENOUGH IS

IT'S TIME SOMEONE ESTABLISHED 'INDUSTRIAL GRADE' COMPUTER SPECS

It's Time Someone Established 'Industrial Grade' Computer Specs. Computers started in clean rooms and then moved into offices. Soon people tried to put them out in the plants where they couldn't stand up to the heat, humidity and other hostile environmental factors.



But, just because a computer is smart enough to run a machine doesn't make it an 'industrial grade' computer. Too much computer hardware that is billed as 'industrial' breaks down in the real world of the plant.

Industrial specifications for military computers are too stringent and too costly to be practical for industrial applications.

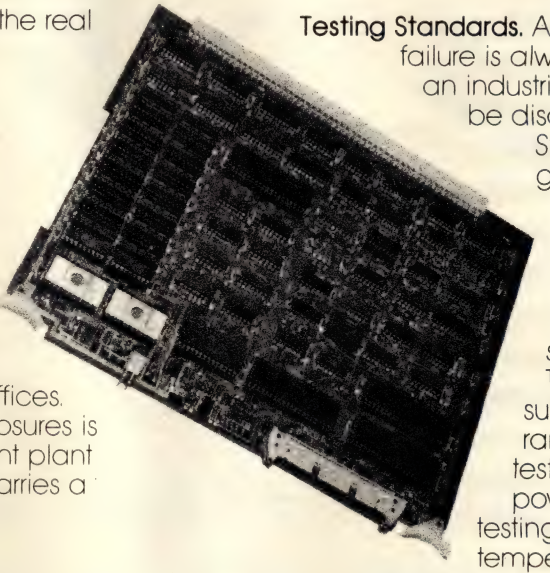
Temperature. We believe that the minumum acceptable 'industrial grade' temperature specification should be 60°C. Factories are not comfortable like offices. The temperature inside sealed enclosures is usually 15°C higher than the ambient plant temperature. XYCOM's '180 + ' line carries a 65°C specification.

Relative Humidity. In a plant, a computer should have a tolerance to relative humidity levels from 0% to 100%. They should also have resistance to condensation. The new XYCOM '180 + ' line with XYCOAT™ meets this stringent demand.

Vibration. Failures due to vibration are virtually always the result of faulty connections, boards or chips. To meet 'industrial grade' spec, chips should be soldered to the board and EPROMs clipped to their sockets. in addition, units should be subjected to 100% full vibration stress and subsequent testing to ensure maximum product integrity.

Contaminant Protection. Salts, dust, dirt and oils are enemies of computers. They even find their way into sealed cabinets in plants. The XYCOM '180 + ' line is XYCOATed to keep contaminants from the boards. (See corrosion.)

Corrosion Protection. Plants are killers when it comes to atmospheric contaminants that corrode and destroy. XYCOAT utilizes a specially formulated shield that protects module components from moisture, fungi, grease, oxidation, salt spray, acids, alkalis, and many other harmful elements. In addition, XYCOM connectors are industry proven gold.



Testing Standards. A computer failure is always bad, but in an industrial situation it can be disastrous. Testing Standards for 'industrial grade' should be higher than for 'commercial grade' All components and assemblies should be tested at all stages of production. They need to be subjected to the full range of dynamic testing which includes power cycling and stress testing under extreme temperatures under microcomputer control for up to 72 hours. This is in addition to our stress vibration cycle. All XYCOM products are tested to our 'industrial grade' standards.

Warranty. For industrial purposes a warranty needs to cover the period soon after installation when most failures will occur. We believe that a year warranty offers the most desirable cost to reliability ratio for both manufacturer and user. It is our philosophy that, although the extent of our testing is extensive, the resulting savings due to greatly reduced warranty claims keeps XYCOM products competitive and your plant operating.

ENOUGH!

...AND STOP SENDING BOYS TO DO MEN'S WORK

Introducing the XYCOM 180 + Line. Now, we are setting a new standard for the others to match. Every '180 +' module is XYCOATed and uses gold connectors. Our regular 180 line meets most 'industrial grade' specs which is sufficient for most factories. The '180 +' line exceeds 'spec' and is for even tougher environments.

COMPARE 180 +™ 'SPEC FOR SPEC'

We've told you what we think 'spec' should be. Look at how our '180 +' line shapes up and compare us with any other product that espouses to the 'industrial grade' designation.

Common Features	Intel	DEC	Motorola	Others	XYCOM 180 +
Temperature					65°C
Relative Humidity					0% – 100%
Vibration					100% Vibration Stress
Contaminant Protection					XYCOAT meets petroleum industry standards
Testing Standards					100% Accelerated burn-in with power cycling, full dynamic testing
Warranty					1 year

Specific '180 +' Features

Digital I/O: T^2L I/O, 64 channel.
64 channel power out.

CPU: Minimum Cost CPU.
High Performance CPU.

Memory: Multiple 65k EPROM cards.
Multiple 65k RAM cards.

Analog I/O: 12 bit, 300 v common mode integrating A/D.
8 channel, 4 to 20 ma isolated D/A.

Software: Multitasking Runtime Executives,
Assembly. Fortran IV, Industrial Pascal.

Accept the XYCOM Challenge (You could win a week for two to Club Med, Cancun.)

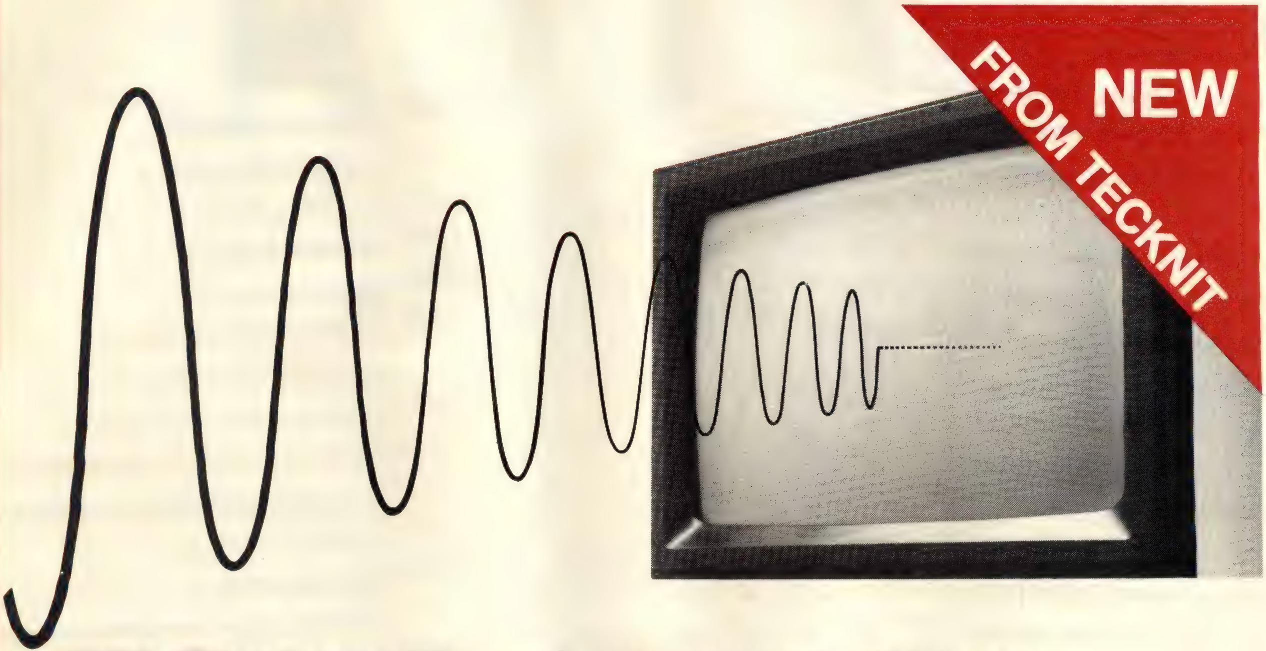
We want you to compare the XYCOM '180 +' line with any other product that aspires to the 'industrial grade' designation. Just fill in the specifications for any competitive industrial computer, fill in your name and address and send your entry to us. Everyone that makes a comparison gets a gift. One entry per person. The grand prize winner will be selected by drawing before September 30, 1980. Entries must be received by July 31, 1980. The trip must be taken between January 1, 1981 and May 31, 1981.

Name ____________ Title ____________
Co. ____________ Address ____________
City ____________ State ____________ Zip ____________

P.O. Box 984
Ann Arbor, Michigan 48106
Phone: (313) 429-4970
TWX: 810-223-8153

xycom™
The Hardhat Computer People

CIRCLE NO. 38



TECKSHIELD® WINDOWS CUT EMI MORE THAN ~~50~~ 60 dB AT 1GHz

WITHSTANDS RIGOROUS MILITARY TEMPEST TESTING!

TECKNIT'S TECKSHIELD High Performance Windows combine optimum EMI shielding with excellent optical characteristics. **TECKSHIELD** windows perform dependably even in severe interference environments.

Design Features

- Special low-resistance mesh fully laminated between two layers of glass, acrylic, polycarbonate, or combinations of these materials.
- Curved windows for CRT computer terminals, word processors, and other CRT-based displays.
- Flat windows for maximum protection of teleprinters, LED, Nixie tube, and other flat displays.
- Color filters and polarizers for contrast enhancement.
- Uniform mesh-to-enclosure continuity around the entire perimeter of the shielded aperture.
- Good viewing screen image with minimum distortion.

TECKSHIELD High Performance Windows are specially designed to solve tough viewing aperture shielding problems. For further information contact the **TECKNIT** representative nearest you.

U.S. Sales Offices: ☐ **Cranford, NJ:** (201) 272-5500.
☐ **Santa Barbara, CA:** (805) 963-5811.

International Representatives: ☐ **England:** Dricom Ltd. (Woking, Surrey), Tel: WOKING 62465. ☐ **France:** Altoflex (Paris), Tel: 372-81-88. ☐ **Israel:** Mechatronics Engineering, Tel: 03-761927. ☐ **Japan:** Industrial Suppliers Co., Ltd. S.A. (Tokyo), Tel: 403-0471.

TECKNIT®

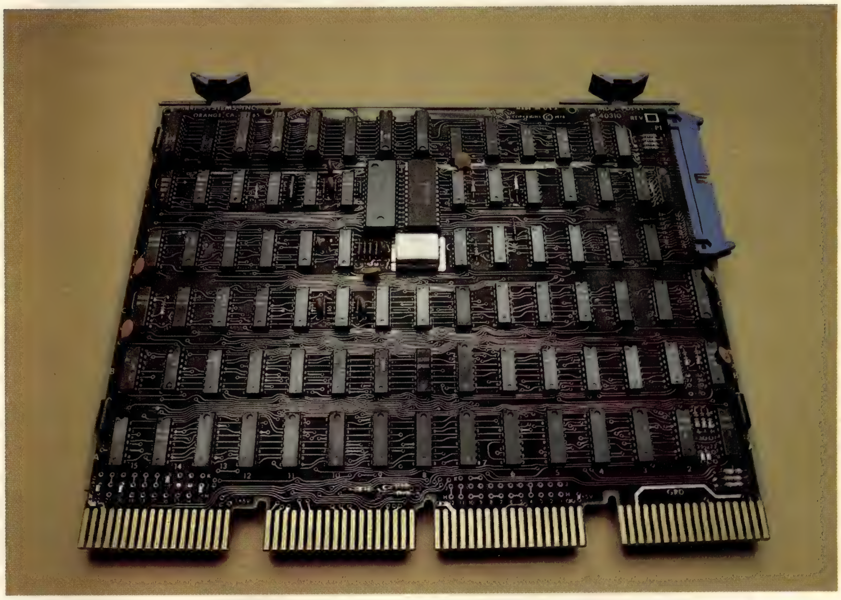
EMI Shielding Division **320 North Nopal Street • Santa Barbara, CA 93103 • (805)963-5811**

Controller links peripherals with Unibus

A controller module called the PDI-11 by MDB Systems ensures DMA operation between Digital Equipment Corp.'s PDP-11 Unibus and any byte-oriented peripheral device. What's more, being small and cost-effective, it should particularly suit displays, including plasma displays, and plotters and printers—peripherals that up to now have had to operate with serial data transfer from the system CPU.

In addition, the PDI-11 features not only PIO compatibility but also compatibility with long-line operation.

Unlike comparable controllers, which usually sit on a hex board, the PDI-11 is small enough to sit on a quad-size board. The quad card takes up only four of six slots in the PDP-11 chassis instead of the full six required by the larger board. In addition, the controller fits into a standard small-peripheral-controller slot on the Unibus.



Being PIO-compatible, the PDI-11 allows a peripheral device to appear to the computer software like any of DEC's DL serial line units. Thus, the user can integrate the board into his system and immediately run a peripheral device with existing software before DMA software has been fully developed and integrated.

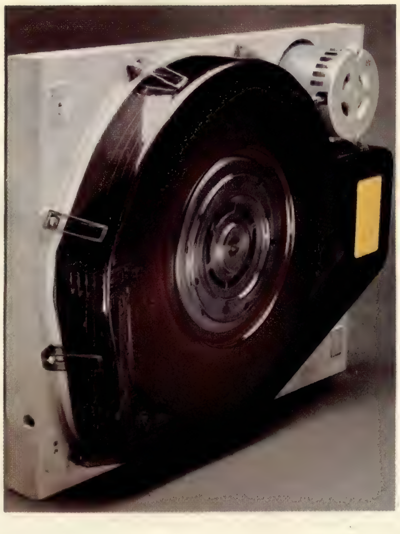
In single quantities, the PDI-11 costs $2150 and is available in 60 days ARO.

MDB Systems, Inc., 1995 N. Batavia St., Orange, CA 92665. Don Perkins (714) 998-6900.
Booth No. 2117 **CIRCLE NO. 484**

14-in. Winchester provides 58-Mbyte capacity

A 14-in. Winchester-disk drive from Shugart combines 58-Mbytes storage capacity with such high-performance capabilities as 7.1-Mbit/s transfer rate, 65-ms average access time and 10.1-ms average latency. In addition, the error rates are one per 10^{10} bits for soft read errors, one per 10^{12} bits for hard read errors and one per 10^{6} bits for seek errors.

Two additional disks and eight additional heads enable the SA4100 to provide twice the capacity of the company's previous model, the SA4008, while retaining the compact size of the SA4000 (16.6 × 5.25 × 21.9 in.—421.6 × 133.4 × 556.3 mm) fixed-disk series. Mounted in a 19-in. RETMA rack, the SA4100 uses just 5.25 in. of panel space. And it weighs just 40 lb.



Expected to be available in the fourth quarter, the SA4100 will sell for less than $2500 in OEM quantities.

Shugart Associates, 435 Oakmead Parkway, Sunnyvale, CA 94086. (408) 733-0100.
Booth No. 2462 **CIRCLE NO. 485**

Look at the high end of TM 500.

High performance when you need it for test and measurement.

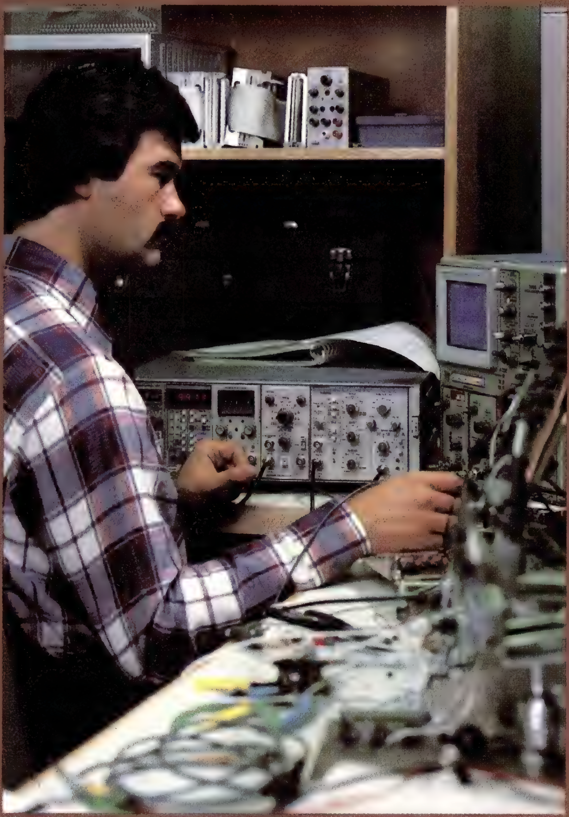
When you're testing sophisticated equipment, you need high performance instrumentation to do the job right. And that's what TM 500 gives you. Consider the following:

The PG 508. Supremely flexible triggering plus delay, variable rise and fall, amplitude compatibility from ECL to CMOS, counted burst capability, and more.

The FG 504. Linear and log sweep, AM and FM, phase lock, triggering, and gating. Operates from 0.001 Hz to 40 MHz.

The DC 508. A frequency counter to 1 GHz with an audio frequency resolution multiplier. Plus a 9 digit readout.

The DM 501A. 0.05% dc accuracy. 4½ digit readout. 7 functions, including temperature and dB. True rms on ac functions.



The SG 505. A state-of-the-art audio oscillator. 0.0008% thd from 20 Hz to 20 kHz. 10 Hz to 100 kHz overall bandwidth.

The SC 503. A 10 MHz scope with bistable storage. And **the SC 504.** An 80 MHz scope with true X-Y capability.

We've listed some of the top of the line here. There are over 30 additional modules currently available. All fitting into any one of six different mainframes. In whatever combination you desire.

To find out more about TM 500, contact your local Tektronix Field Office, or write Tektronix, Inc.

TM 500 Designed for Configurability

Tektronix®
COMMITTED TO EXCELLENCE

For immediate action, dial our toll free automatic answering service 1-800-547-1512

Tektronix, Inc.
P.O. Box 1700
Beaverton, Oregon 97075
(503) 644-0161
Telex: 910-467-8708
Cable: TEKTRONIX

Europe, Africa, Middle East:
Tektronix Int'l., Inc.
Postbox 827
1180 AV Amstelveen
The Netherlands

Copyright © 1979, Tektronix, Inc. All rights reserved. 860

Winchester drive stores 398.2 Mbytes

Thin-film heads and 685 recording tracks per inch endow a 14-in. Winchester disk drive with a storage capacity of 398.2 Mbytes in a 9.5 × 16.8 × 29-in. package. It records at 12,772 bits per inch. A conventional drive of this size typically stores about 100 Mbytes.

The Model 4835 from Dastek is the first 14-in. Winchester using thin-film heads to be made commercially available by a firm other then IBM. It uses standard currently-available disk media that can be replaced easily for increased capacity when the next generation of media becomes available.

The three models of the 4835 have storage capacities of 199.1, 331.8 and 398.2 Mbytes. For each model, track-to-track access time is 5 ms, average access is 27 ms, and average latency time is 10.1 ms. Data transfers occur at 2.0 Mbytes/s, with the disk rotating at a nominal 2964 RPM.

The short average access time comes from a high-performance linear actuator inside the drive. A closed servo-loop controls the voice-coil actuator. The servo-loop contains a microprocessor that uses positioning information (prerecorded on a dedicated disk surface) to minimize the impact of temperature variations and vibration on loop performance.

Unlike the voice-coil assemblies in conventional Winchester drives, the entire voice-coil assembly of the 4835 is permanently mounted on the disk-drive module frame, which can be replaced on-site in less than 15 min. with no alignment.

A set of internal diagnostics automatically checks out the system during power-up. The diagnostics cover speed and voltage checks, tests of the microprocessor controlling the servo loop and other electronic circuits —the drive has a Z80 for this function—and checks of the error detection and correction logic.

The drive has a data-protection feature, which comes on automatically in response to a drive malfunction or a loss of voltage. It protects data already on the disk from being overwritten during the malfunction. The operator can also activate a write-inhibit switch to prevent the system from writing on the disk during normal operations.

Conveniences for the user come in several forms. First, the drive may be upgraded on site, from one storage capacity to another. Secondly, a switch on the unit lets the user select any number of bytes per sector and sectors per track, to customize the disk for a wide array of operating systems and data formats.

The 4835 disk drives cost 20% to 30% less than currently available storage module drives, according to the manufacturer. First deliveries are scheduled for September.

Dastek, 141 Albright Way, Los Gatos, CA 95030. James Koerber (408) 866-0550.

CIRCLE NO. 493

Portable terminal sends graphics

A portable terminal with full send/receive capability can produce graphics on either paper or transparent film. Made by Computer Transceiver Systems, the Execuport 4000G accommodates either 80-column or full-width, 136-column printouts.

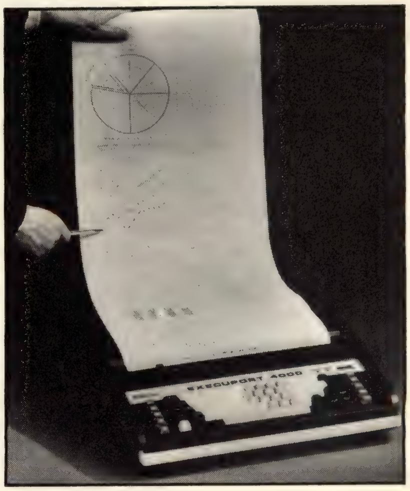
With the terminal's graphics capability, time plots, bar charts and even histograms may all be printed. In addition, the terminal can draw lines in any direction and print with a resolution of 1920 points per square inch.

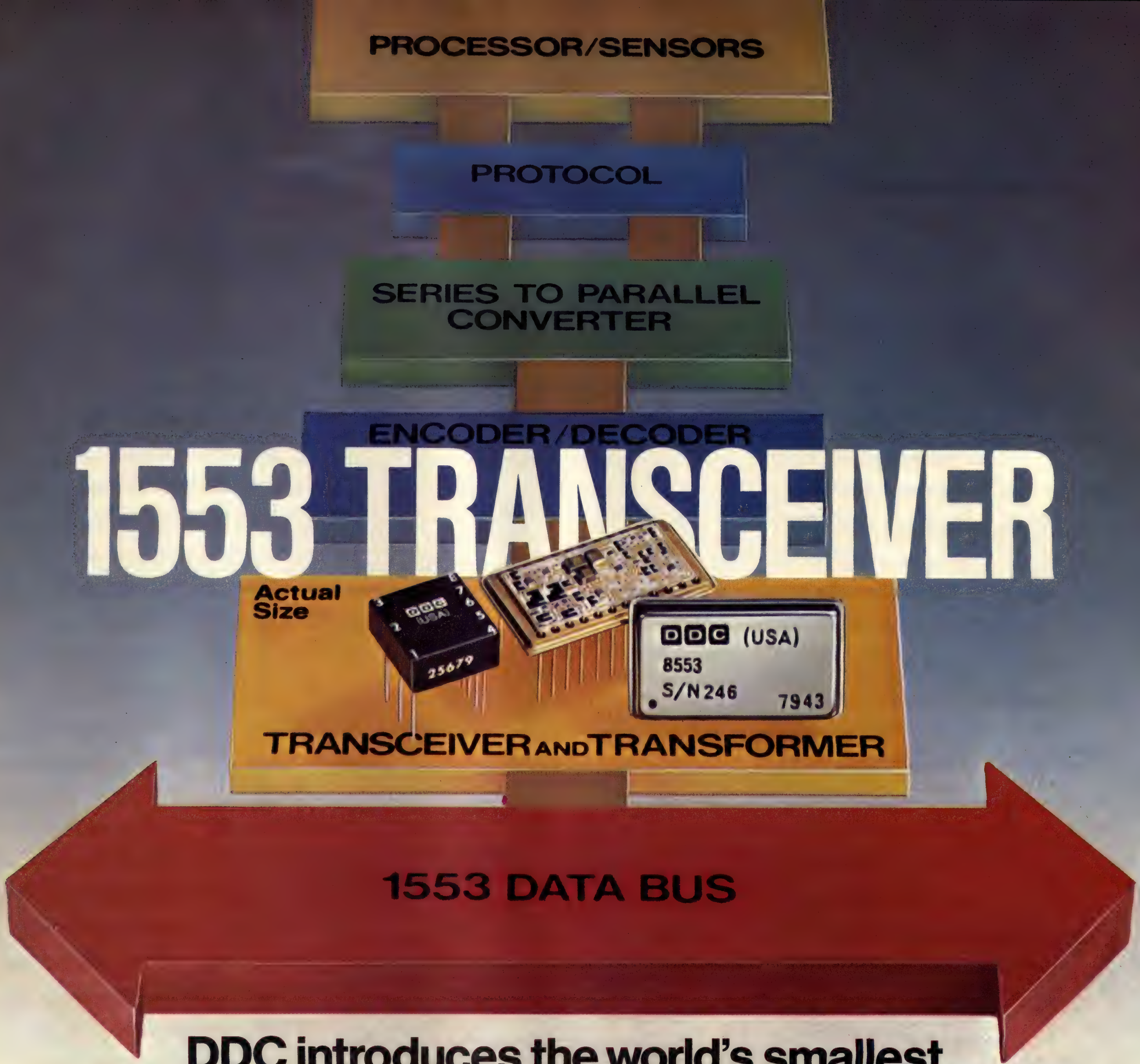
Portable, the 400G can be used at any location with regular telephone service and a standard ac line. Simply inserting the handset of an ordinary telephone into the terminal's built-in acoustic coupler creates an on-line connection with a remote coupler.

In single-unit quantities, the 4000G is priced at $3795.

Computer Transceiver Systems, Inc., E. 66 Midland Ave., Paramus, NJ 07652. (201) 261-6800.

Booth No. 2165 **CIRCLE NO. 490**





DDC introduces the world's smallest 1553 data bus transceiver.

The BUS-8553 data bus transceiver is small in size and big in benefits. Packaged in a single 24-pin DDIP hybrid, the 8553 consumes about one-half the power of other units. The hybrid has a specified external transformer for easy interfacing with the 1553 data bus.

DDC's capability extends to the complete MIL-STD-1553 A and B. The transceiver/transformer is also available as part of a discrete RTU module, complete with encoder / decoder and serial-to-parallel converter.

Consider the BUS-8553 transceiver for your 1553 data bus requirements and see how it can benefit your design. To find out more, write or call Department A-4 today.

DDC™

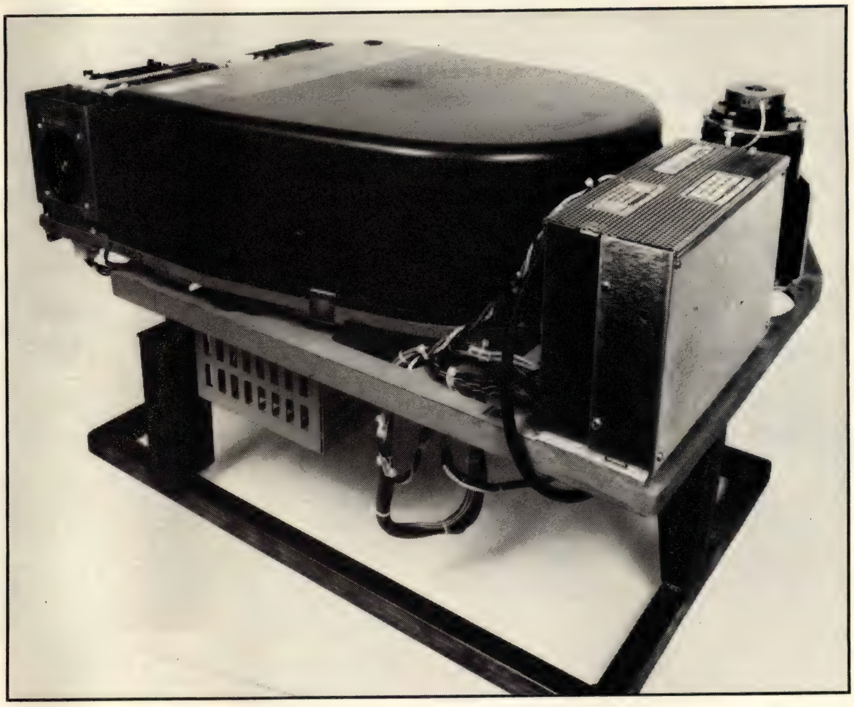
ILC DATA DEVICE CORPORATION

See us at Electro '80, Booth #2342 and #3220

EXECUTIVE OFFICES: ILC Data Device Corporation, Dept. A-4, 105 Wilbur Place, Bohemia, N.Y. 11716, (516) 567-5600, TWX: 510-228-7324
LOS ANGELES: ILC Data Device Corporation, Dept. A-4, 7337 Greenbush Avenue, No. Hollywood, CA 91605, (213) 982-6454, TWX: 910-499-2674
LONDON: DDC United Kingdom Ltd., Dept. A-4, 128 High Street, Hungerford, Berkshire RG17 ODL, England (44) 4886-2141/2142, TLX: 851-848826
PARIS: DDC Electronique, Dept. A-4, 4 Rue De Abreuvoir, 92400 Courbevoie, France, TLX: 842-630609

CIRCLE NO. 40

Dual disk resolves Winchester backup



The strongpoints of four disk drives from Memorex differ; but by any standard the Model 201 8-in. Winchester comes out on top—it offers a solution to Winchester backup problems. The other three drives, all featuring standard SMD interfaces, are the Model 612 (a sealed Winchester drive) and the Models 659 and 677-30 (IBM 3330-type removable diskpack drives).

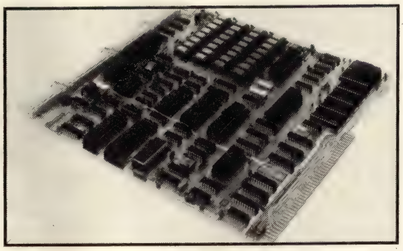
The 201 is both—a fixed disk and a removable disk cartridge. Each storage element offers 12.5 Mbytes of capacity, for a total of 25 Mbytes. The removable cartridge backs up any fixed disk, including that of the 201 itself. The drive accesses in 10 ms (30 ms, average), track-to-track.

The Model 612 sealed Winchester drive comes in three versions, offering 28, 56 or 84 Mbytes of storage. The 677-30 drive is aimed at the 300-Mbyte storage requirements of minicomputers. The Model 659 is a sealed media, with head and disk assembly in the same removable disk pack.

Memorex Corp., General Systems Group, Disc Drive Div., San Tomas at Central Expressway, Santa Clara, CA 95052. (408) 987-1000.

Booth No. 2363 CIRCLE NO. 489

Powerful μC packs it all on one board



For powerful computing in a tight space, look at the TCB-85E: On one printed-circuit board, whose area is less than 144 sq in., the 85E packs up to 64 kbytes of RAM, up to 16 kbytes of ROM or PROM, an Intel 8085A-2 10-MHz CPU and virtually every interface.

The interfacing lineup includes a double-density, double-sided floppy-disk controller, a programmable CRT controller, a serial I/O port, a parallel interface for printers, a strobed or scanned interface for keyboards, a programmable interrupt controller and a DMA channel. Add to those a CP/M operating system and high-level Pascal software support, and a designer has all the makings for almost any kind of processing system—be it engineering, scientific, process control or business—and the capability to communicate with almost any outside facility. That means computers, mass storage, various peripherals or even operators.

If all those capabilities still are not enough, the TCB-85E's compatibility with the Intel Multibus system architecture makes the board amenable to future expansion through the addition of options.

With 48 k of RAM, and in quantities of ten, the DOSC TCB-85 will cost $1495.

DOSC, Inc., 175 I.U. Willets Rd., Albertson, NY 11507. (212) 895-5510.

Booth No. 3419 CIRCLE NO. 481

We can give you the power to solve a hot problem.

Heat is a recharge-ble battery's biggest enemy. At about 45° C life starts to shorten dramatically. The new Polytemp™ s a NICAD® nickel-cadmium battery designed to take the heat and give long ife. Satisfactory ife to 70° C.

Polytemp's long life in high temperature applications makes it an ideal battery for backup power in memory circuits, emergency lighting and alarms, telephone and telegraph equipment, electronic instruments and process control equipment.

And Polytemp batteries have a unique negative electrode construction which means less voltage depression during overcharge than sintered nickel matrix types. A radial compression seal gives greater protection to surrounding circuits.

A battery that leads a hot life doesn't have to lead a short life. Now there's Polytemp from Gould. The company that makes more different types of batteries than anyone else in the world.

Available in sizes "½ AAA" to "F." (0.070 amp. hours to 7 amp. hours.) For complete design spec's write:

Applications
Engineering Mgr.
Gould Inc.
931 Vandalia St.
St. Paul, MN 55114

GOULD

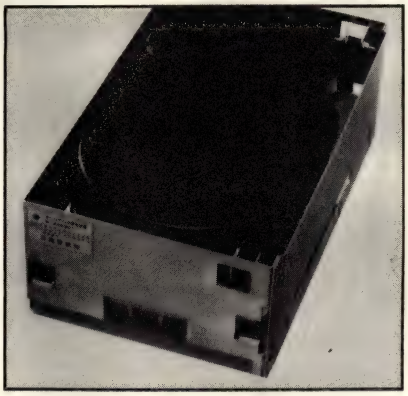
An Electrical/Electronics Company

NCC Products

8-in. Winchesters feature SMD interface

Hitachi America, Ltd. enters the 8-in. Winchester marketplace with two disk drives that not only provide sufficient storage but also address the interface problem plaguing other manufacturers. The DK801-1 provides 6.9 Mbytes of unformatted and 5.2 Mbytes of formatted storage; the DK801-2 offers 13.9 and 10.4 Mbytes, respectively. What's more, both offer an SMD interface, something other manufacturers have found too expensive.

Another distinguishing feature is the shock mounts incorporated into the drives' outer frame. These mounts protect the inner-sealed Winchester-drive assembly from shocks that might damage the heads of the drive assemblies. Even so, the package size is still just 9.5 × 5.7 × 15.2 in. (240 × 145 × 385 mm), and the weight is just 22 lb (10 kg).



Built with the IBM 3350-type technology employed on the company's larger disk systems, the units offer an average access time of 70 ms (maximum 150 ms) and an average latency time of 8.4 ms. Data are transferred swiftly at 889 kbytes/s.

Like many other 8-in. Winchester drives, the DK801-1 and DK801-2 use the IBM-size 210-mm disk. Heads and media for the drives handle the disk's 7300-bit/in. and 200-track/in. recording density.

Evaluation units will be available this coming August, with production scheduled to begin by year's end. The drives are expected to cost under $1500.

Hitachi America, Ltd., 100 California St., San Francisco, CA 94111. Kiyoshi Fudono (415) 981-7871.

Booth No. 4309 **CIRCLE NO. 482**

Matrix printer produces graphs, words

With three dot densities, the Slimline SLG matrix generates both graphics and alphanumerics. It displays graphics in a pattern of 100 × 100 dots per inch, at a plotting speed of 12 inches per minute; produces routine reports in two high-density patterns, at 400 lines per minute; and completes correspondence in two low-density patterns, at a fast 120 lines per minute.

In graphics mode, the SLG reproduces anything that can be displayed on a CRT screen, including areas of solid black. Along with graphs, maps and bar charts, the SLG prints special characters for Arabic, and other languages.

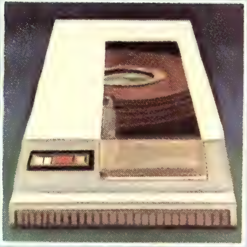
In its alphanumerics mode, the printer forms high-density characters using 7 × 9 and 7 × 12 matrices. For low-density characters, it employs matrices of 7 × 5 and 7 × 6.

Okidata is also introducing two low-cost, yet heavy-duty, matrix printers for alphanumerics only—the Microline II and the Microline III.

Okidata Corp., 111 Gaither Dr., Mount Laurel, NJ 08054. (609) 235-2600.

Booth No. 2227 **CIRCLE NO. 487**

We can custom-fit standard motors to suit your special designs.



With a little alteration to any of our standard catalog items, we can tailor the motor configuration you need—without high costs or long delays.

Need special windings, lead lengths, terminal ends, mounting brackets? A certain torque at a prescribed speed? Special gear train? Of all the precision motors we deliver, 75% are customized. Our sales engineers will work with you to solve design problems or meet unusual application conditions.

Whether you need a stepper motor the size of a quarter, or a brushless d.c. motor to drive 14″ rigid disks, write for our free catalog of standard motors. We'll show you where we start; you take it from there. AIRPAX/North American Philips Controls Corp., Cheshire Industrial Park, Cheshire, CT 06410. Phone (203) 272-0301.

AIRPAX®

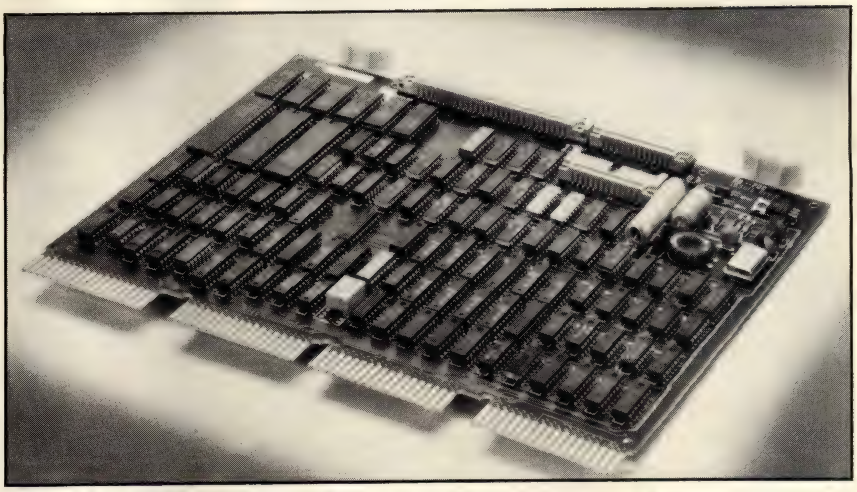
NORTH AMERICAN PHILIPS CONTROLS CORP.

Cheshire Division

CIRCLE NO. 42 FOR IMMEDIATE NEED

CIRCLE NO. 43 FOR REFERENCE ONLY

Controller links two Winchesters



An intelligent disk controller by Dilog (Distributed Logic Corp.) permits computer interfacing to any two 8-in. or 14-in. Winchester drives, as well as to SMD-pack or CMD cartridge-type drives. Compatible with the PDP-11 minicomputer made by Digital Equipment Corp., the DU-202 comes as a single quad-size printed-circuit card and fits in one Unibus SPC card slot.

The controller, which employs a microprocessor-firmware architecture, interfaces very easily to a variety of industry-standard disks through an SMD cable—and without an external power chassis. It accommodates two drives of the same type or different types, or two drives having different storage capacities or different transfer rates. Winchester drives may store 20 to 160 Mbytes.

It sells for $1786; delivery is from stock to 60 days.

Dilog, 12800-G Garden Grove Blvd., Garden Grove, CA 92643. (714) 534-8950.

Booth No. 3110 CIRCLE NO. 483

Self-prompting computer is easy to use

Distributed processing takes another step closer to portable processing, by means of a self-prompting computer from Computer Devices Inc. Because the Miniterm Model 1206/PAT (programmed applications terminal) relies on preprogrammed modules, personnel with little or no training in data processing can operate the computer in data-entry and computing applications.

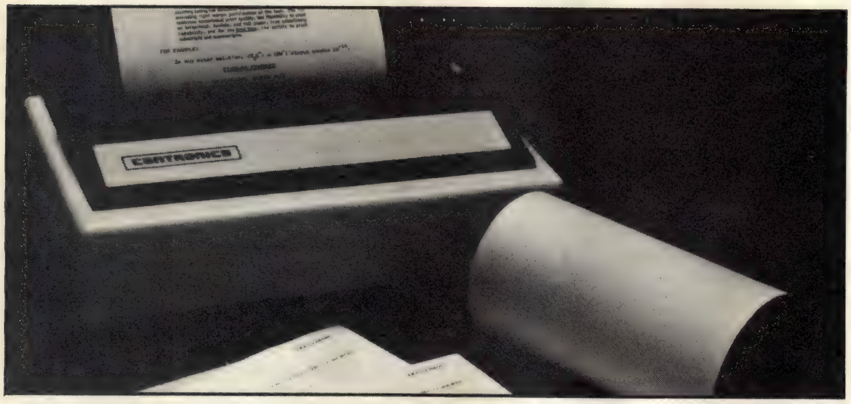
Keyboard mode selection, line length, code format, memory allocation, tape control, indexing, line rates, parity and print density are all controlled—automatically and exclusively—by the prompting program. The applications programs are written either in Basic or in Motorola 6800 assembly language. They are loaded into the 1206/PAT through minicassettes or other optional storage media.

The 1206/PAT will be available in the third quarter of 1980. In unit quantity, the standard version will cost $5195.

Computer Devices, Inc., 25 North Ave., Burlington, MA 01803. (617) 273-1550.

Booth No. 1447 CIRCLE NO. 491

Mini printer turns out quality text



Few printers, if any, that sell for less than $1000 can match the line-up of features in the Centronics 737. The small computer bangs out correspondence-quality text on its nine-wire dot-matrix print head; it gives proportional spacing, justifies the right margin (with the help of the host computer), moves paper forwards or backwards and accepts letterhead, fanfold or rolled paper.

For standard data-processing text, the miniprinter's 7 × 8 dot matrix offers densities of 10 or 16.6 characters per inch, delivered as fast as 50 characters per second (cps). For proportionally-spaced copy, the 737's N × 9 dot-matrix mode operates at 80 cps.

To underline or produce lowercase descending characters or print subscripts and superscripts, an operator can roll the paper forward or backward in half-line steps—a first for any miniprinter. The 737 also generates expanded print for headlines and column subheadings.

This nimble miniprinter features a 96-character ASCII set, a full one-line buffer, 21 line-per-minute (lpm) operation with 80-column printout and 58 lpm with 20-column printout, vertical spacing at six lines per inch, and a paper tear bar. At $995 the price of the Centronics unit cannot be beat.

Centronics Data Computer Corp., Hudson, NH 03051 (603) 883-0111.

Booth No. 1549 **CIRCLE NO. 488**

Computers do more than compatible IBMs

The QMX-6300 computer series—three processors with 0.5 to 4 Mbytes of main memory—offers a plug-compatible alternative to midscale IBM 370s and 4300s while providing up to 170% more computing power than 4300s, according to its manufacturer.

The QMX architecture incorporates a multiple-bus structure and includes an independent service processor, which provides diagnostic functions, monitors system resources and initiates automatic recovery in the event of subsystem failures. In addition, it allows remote diagnosis.

The first system to come, the QMX 6336, will reportedly have the equivalent of 130% of the power of an IBM 370/148. Memory-cycle time is 495 ns per 8 bytes, and machine-cycle time is 175 to 350 ns, with simultaneous multiple-instruction processing capabilities.

The QMX 6336 will have one integrated-byte multiplexer channel and two integrated-block multiplexer channels as standard. Channel data rates of 50 kbytes/s in the byte mode and 2 Mbytes/s in the burst mode can be achieved on individual channels, with a data rate of 8.05 Mbytes/s.

The QMX 6333, available in January, 1981, is expected to provide up to 170% of the performance of the IBM 4331 while also providing greater memory and channel capacities. Main memory ranges from 1/2 to 2 Mbytes.

The QMX 6343, available later in 1981, is aimed at the IBM 4341. Main-memory capacities range from 2 to 4 Mbytes.

The QMX 6336, depending upon configuration, will range from $163,000 to $212,000. The QMX 6333 will range from $98,000 to $123,000. Pricing for the QMX 6343 has not been set.

Nanodata Computer Corp., One Computer Park, Buffalo, NY 14203. (716) 845-6000.

Booth No. 3015 **CIRCLE NO. 492**

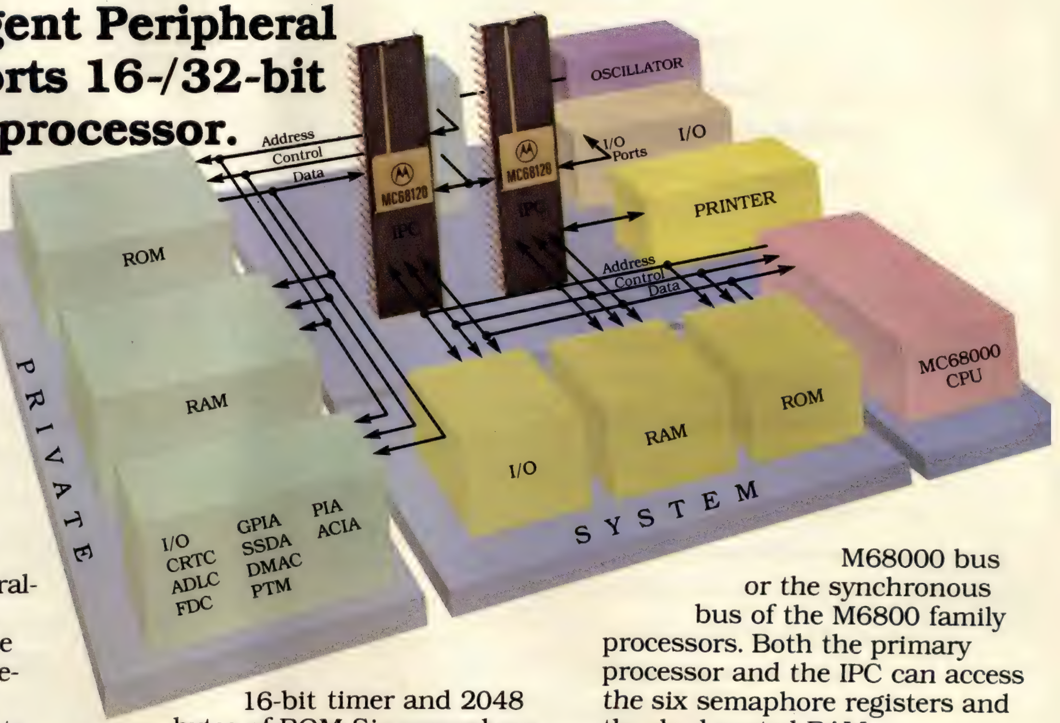
Motorola Reports

INTELLIGENT PERIPHERAL CONTROLLER

- □MC68120 IPC launches com
  M68000 peripheral-chip fam
- □LSI simplifies telecommunic
- □A switch to power supply ec
- □New help for system data se
- □Fast fiber optics scores agai

MOTOROLA INC.

Motorola Intelligent Peripheral Controller supports 16-/32-bit MC68000 microprocessor.



Motorola's new MC68120 Intelligent Peripheral Controller (IPC) is the first in a complete peripheral-chip family for support of our advanced 16-/32-bit MC68000 microprocessor.

The powerful MC68000 is in volume production and is available both in chip form and as the brains of the '68KDM design module at the board level.

The MC68120 IPC is a general-purpose, user-programmable peripheral control unit, and the first of the MC68000-system peripherals we will announce in 1980. It's an ideal supplement to the existing family of Motorola support peripherals and provides next-generation enhancements to the MC68000-based systems of today.

Use the IPC for local or customized peripheral control, as an I/O preprocessor or as a satellite processing unit for distributed processing. Typical applications can include functions of a file handler, intelligent floppy disk or hard disk controller, data communications protocol controller, GPIA bus management controller, CRT driver and many others.

The MC68120 is both software and bus compatible with the synchronous bus of the M6800 family processors and peripherals, as well as with the asynchronous bus of the MC68000 for which it was primarily designed. The control program, up to 64K bytes in length, can be stored in the on-board ROM or in external memory which is accessible in one of the expanded operating modes.

Speaking of operating modes, the MC68120 will operate in any of eight Single-Chip, Expanded Non-Multiplexed, Expanded Multiplexed and Test Modes. The IPC contains a dual-port 128-byte RAM with system bus interface, serial communications interface, 21 parallel I/O lines, *multi*-function 16-bit timer and 2048 bytes of ROM. Six semaphore registers are accessible to both the on-board CPU or an external processor. The CPU executes an enhanced '6800 instruction set and includes an 8 x 8 multiply. The programming model features two 8-bit accumulators which can be used separately, or together to form a 16-bit accumulator.

Access to the MC68120 by the primary processing system is via the IPC's System Bus, which interfaces with either the asynchronous M68000 bus or the synchronous bus of the M6800 family processors. Both the primary processor and the IPC can access the six semaphore registers and the dual-ported RAM.

The IPC is a vital, versatile M68000 system component, one of an ever growing family. Watch for the announcements of more family components soon. In the meantime, the MC68000 is available for evaluation and design-in with high level software and a complete development system.

It's a fast-paced world. M68000 systems can help your products stay in front.

Check ☐ A for information.

Motorola committed to meet standard CMOS demand

Motorola presently offers the industry's best delivery performance of the widest existing selection of CMOS standard functions. Delivery of most standard types is 10 weeks or less, and our capacity is still growing to meet increasing demands.

Two new brochures, the *CMOS Function Selector Guide* and the *CMOS Cross Reference Guide*, detail this broad Motorola standard logic CMOS family.

The selector guide lists more than 110 standard series devices by number and function, plus B Series and UB CMOS information.

Also included is a description of Motorola's "Better" program of three different process flow levels for enhancement of commercial device reliability at a fraction of military grade product costs.

The cross reference lists second sources by device type for Motorola standard CMOS ICs.

As greater complexity is achieved, such as the single-chip combination of analog and digital, CMOS op amps and frequency synthesizers, CMOS viability as an LSI technology is clearly confirmed.

With the broadest standard product line and a factory equipped to meet growing product demand, Motorola enters the '80s prepared to maintain and increase our leadership role in standard CMOS.

Check ☐ B for information.

Cut system cost down to size with our multi-output mini-switcher.

Now you can have a full-featured switching power supply with all the quality and reliability of bigger, more expensive units without all the cost.

Motorola introduces the 0FS65 economy series of open-frame supplies designed for MPU, terminal, display system and other lower-power applications requiring outputs from 25 W to 65 W.

Cooler and more efficient than equivalent linears, parts count for the family is about 20% less than similar switcher types for higher MTBF — also a key cost reducing element. There are no fans needed for cooling, the design boasts about 1.5 W output per cubic inch and efficiency for the triple-output supply is approximately 65%.

Small and lightweight (about 21 oz.), the 0FS series offers sophisticated, Cadillac performance in an economy car framework. Fully self-protected from abuse at output terminals, shorts and opens can't damage it with high, low, or in-between voltages. Overload simply causes periodic recycling with normalcy restored when overload is gone.

And if your system's going to crash due to power line failure, it sends a warning signal to the MPU to unload volatile memory with output voltage remaining within regulation for 32 ms after loss of nominal line voltage. That's about twice as long a hold-up time as others offer.

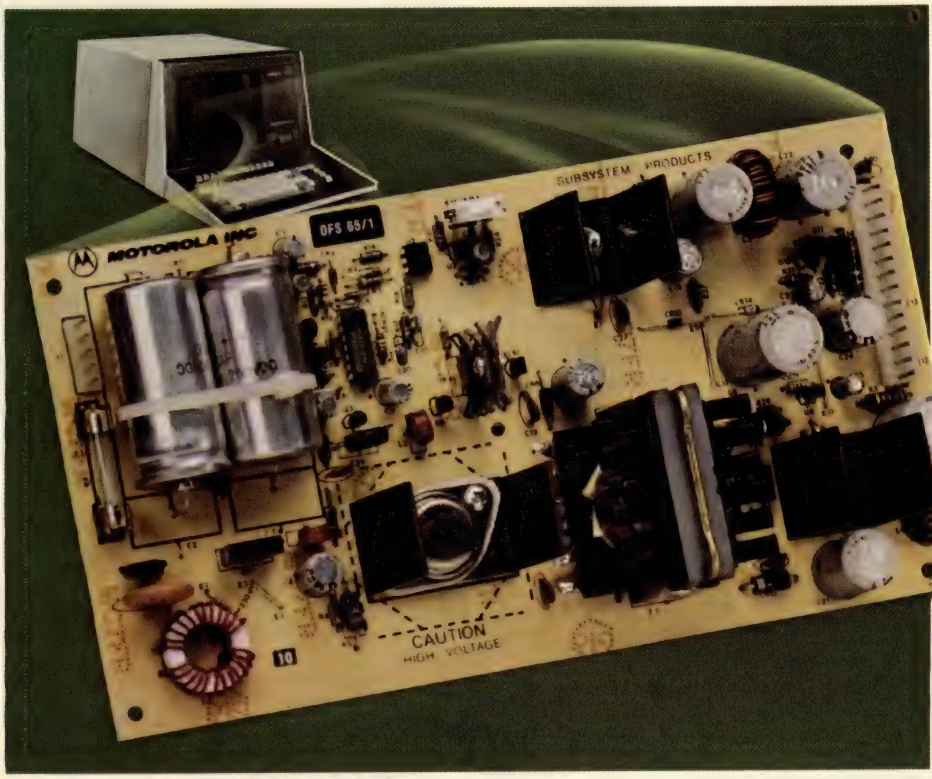
Of course, it provides EMI filter on input, soft start and reverse polarity protection.

Standard, 24-hour burn-in is included and reliability ensured through computer-aided, worst-case analysis and individual testing of every IC and discrete device.

Max load and line reg for the +5, +12 and +15 V outputs are 1% and ± 0.15% and 6% and ± 0.15% for the −12 V and −15 V outputs.

Best of all, prices are down where they should be: $130, 100-249 — and you have Motorola's reputation for quality, integrity and conservative design in the bargain.

Check ☐ C for information.



Kiss complexity goodbye with the first 100 mA, 3-terminal adjustable voltage regulator.

Say hello to LM117L/217L/317L — the first low-current, linear voltage regulator to use just two resistors to set output voltage.

Because it's packaged in a compact TO-39 or TO-92, it's ideal for use freely in spot regulation throughout a board. No large, expensive, single regulators that may or may not keep every isolated subsystem on track. No cross-talk, no loss through line resistance.

Because it's adjustable, there's no need for op amps, caps or stocking many fixed voltages to attain adjustability.

Because it's positive, the IC obviates need for ground referencing. Since you need only a differential voltage to set up V_{out}, the regulator never sees more than the V_{in}-V_{out} value. Operation in floating systems at high voltages with respect to ground is easily attained.

And because it's simple, easy and economical, you have regulation exactly where you want it.

Except for I_{max}, the LM117L/217L/317L provides the same fine specs as the 1.5A LM317: adjustable ouput range from 1.2 V to 37 V; internal thermal shutdown and short circuit protection; ripple rejection almost twice as good as the MC78L series and output transistor safe-area compensation.

Line reg's 0.05%/V max for the '117L/217L and 0.07%/V for the '317L. Type numbers designate military, industrial or commercial temp range.

100-Up price for the LM317LZ series is just 52¢.

Check ☐ D for information.

TYPE	100 mA	500 mA	1500 mA
Pos Adj	117L		117
Pos Fixed	78L00	78M00	7800/C/A/AC, 140/340*
Neg Fixed	79L00		7900C

*Tighter-spec'd 7800 version in TO-3.

A single fast LSI chip increases system security.

You can build extra data protection into your system now with a single LSI device, and still get 400K bps speed.

Motorola's MC6859 provides both the unusual two-key security capability and great speed in performance of the National Bureau of Standards data encryption algorithm. It's far the fastest data security approach able to supply two-key protection.

Previously we made this data encryption device available only as a proprietary function installed in modules and stand-alone systems. Now it's also available in chip form for any system dealing with sensitive or confidential information such as in banks, insurance firms and credit card companies.

The NBS encryption algorithm has been widely accepted as an industry standard for system security. It calls for the "scrambling" of confidential information to make it unintelligible to unauthorized parties. All qualified schemes operate basically by transforming 64-bit (8-byte) words into different 64-bit words, using a 56-bit "key" to determine the coding. When the key is known, the scrambled data can be deciphered.

Motorola's MC6859 design allows optimum security and flexibility. It permits several approaches for coding the algorithm. For example, the primary key may encrypt a "coded text" secondary key which is in turn used for encoding the algorithm. In another approach, the primary key may be followed by a "plain text" secondary key. Or, the user may elect to use only a single key.

The MC6859 is a fully compatible member of the M6800 family and operates with all family microprocessors and microcomputers, including the MC6809 and MC6801. As with the other M6800 family peripherals, it can also be used in systems based on the 16-/32-bit MC68000.

Check ☐ E for information.

5 V EPROMs . . . from 16K to 64K, lowest power and high speed. Immediately available.

The industry's broadest 16K-to-64K family of 5 volt EPROMs is now available from Motorola.

The lowest-power types in the industry, and some of the fastest, are included. They aren't simply introduced, they're available for your use.

Our low power 16K and 32K types operate on just half the power of any others. And the MCM68L764/68L764-35 are far and away the lowest-power 64Ks. This is power performance unmatched anywhere. Our high-speed 16K and 32K selections have maximum access times down to 250 ns.

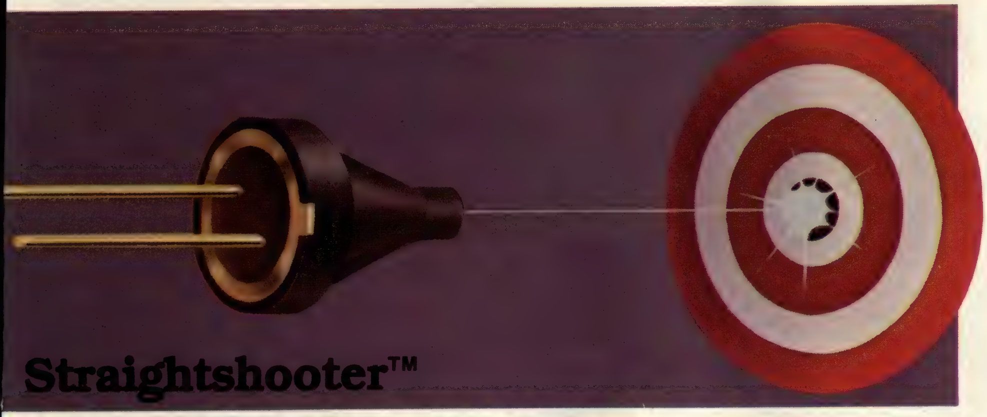
These 5 V EPROMs, including the 64Ks, are also pin compatible, in the same 24-pin package as the 8K through 64K industry standard mask-programmable ROMs. Even the 64K EPROM is a "plug-in" replacement for these ROMs, and for the smaller 5 V EPROMs.

Added attractions such as on-chip overvoltage programming protection circuitry and superior data retention capabilities help put these 5 V EPROMs in a class by themselves. And, by superior data retention, we're talking about a failure rate of only 0.001%/1,000 hours. The high-performance versions are all ±10% supply devices.

Order Motorola 5 V EPROMs now from your local Motorola sales office or authorized distributor.

The 5 V EPROMs are another piece of solid evidence, with our 64K RAM and industry-standard mask-programmable ROM family, that Motorola has taken the lead in MOS memories.

Check ☐ Q for information.



Straightshooter™ fiber optics right on target again with fast LED, detector.

We've notched another bullseye with the introduction of two new Straightshooter devices, each possessing superior response times over previous units.

The PIN photodiode, MFOD104F, has a typical response time of 2 ns at 20 V and 6 ns at 5 V . . . , 10 times faster than other ferrule types. It fits right into analog fiber optics sytems requiring bandwidth up to 100 MHz and in digital systems with speed requirements to 200 MBaud. In data comm links operating at 5 V the detector's usable to 110 MBaud.

The MFOE103F LED emitter offers 15 ns typical t_{on}, t_{off} and is usable in systems to 110 MBaud.

Straightshooter packages are designed to fit directly into AMP Optimate connectors for easy, accurate interconnect with FO cables.

The Straightshooter ferruled package offers greatly improved light transfer efficiency between active device and fiber through intimate bonding of the fiber to the light-emitting or detecting surface of the semi chip. Plus rugged construction well-suited for high-volume, cost-cutting manufacturing and simple, highly-efficient interconnect due to unique, interactive design of device package and cable connectors.

In fact, the only remaining variables for you to figure out are diameter and numerical aperature of the cable according to transmission requirements. Coupling losses are easily calculated.

New, low, 100-up prices on the PIN and LED are $23 and $27.50. Complete-line data sheets are available too, as is the new Motorola LINK kit. It lets you explore the many advantages of FO systems with Straightshooter emitters, detectors, and AMP connectors. It includes basic design equations and examples, circuit ideas and data sheets for just $99.

AMP and Optimate are trademarks of AMP, Inc.

Check ☐F for information.

Motorola launches 400 mW glass zener into Dash 1 orbit.

That old, established zener that's everybody's commodity and nobody's state-of-the-art has taken another impressive leap forward at Motorola . . . qualification to MIL-STD-19500/117D/127G Dash 1 specs which include JAN, JTX and now the first metallurgically-bonded JTXV units.

In fact, we've never stopped improving the 1N746/957/4370 family. Unlike others, it offers metallurgical bonding over the entire line — from 100 V to 1.8 V. Not a solder, but a homogeneous intermix of metal molecules between die and lead, the bond ensures true metal continuity throughout, superior structural strength, thermal conductivity and electrical integrity from end to end.

In addition, the Motorola DO-35 offers zero-defect material, low-temp glass compatible with the alloy process for sharper breakdown and lower leakage, computerized diffusion and testing, oxide passivation, laser scribing, automatic inspections, MOS-inspired processes, 100% contact tests and the largest active area with the biggest surge current rating of any DO-35.

Not your average zener, by any means.

Check ☐G for information.

Schottky rectifiers lead total switcher support parade.

Motorola's got it all in Schottkys and fast-recovery units for the 5 V output side and standard recovery devices for the line-voltage inputs in switching power supplies. Plus a new Switchmode™ rectifier application guide.

Our eighteen 1 A to 75 A Schottky units are suitable for 1 A to 250 A (per leg) output designs and offer technological improvements that keep the outside world outside . . . an extra layer of barrier metal that effectively shuts out contamination and failure. Extensively used in LS fabrication, the layer is an interface between working barrier metal of chrome or platinum and the nickel-gold ohmic contact metal.

We tested 840 DO-4 and DO-5 units to MIL-STD-750 criteria, with no-failure results (full reports with variables data are available).

Our fast recovery units for output currents of 0.5 A to 50 A (per leg) are considered by the industry as the finest in the world. And the most available.

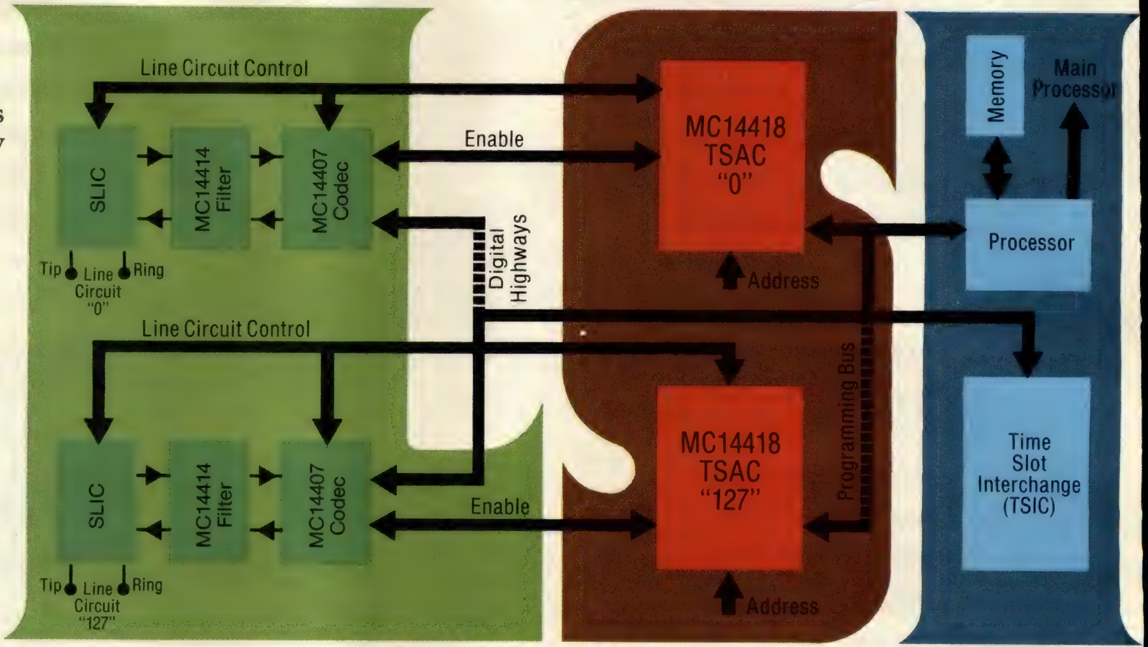
And our line of standard speed rectifiers and bridges for 1 A to 25 A line voltage use includes the Motorola-originated 1N4000 Surmetic™ series that has set the low-cost, high-volume standard for the past 15 years.

Check the reader response and receive a new Switchmode rectifier guide for your next switching power supply design.

Join the Motorola parade.

Check ☐H for information.

LSI telecommunications circuit cuts per-channel part count.



Motorola's third major MOS LSI telecommunications function introduction in less than a year opens a new approach to per-channel time slot assignments, and simplifies the implementation of a variety of complex control functions.

It's the Time Slot Assigner Circuit. We call it the TSAC. It's an addressable, programmable per-channel unit that allows programming of the variable Codec time slot assignment through a serial microprocessor port. One Codec is assigned to each TSAC. In operation, the major function of the TSAC is to assign the Codec to transmit and receive time slots in a digital serial data stream.

Two versions of the TSAC are available. The MC14416 is a 16-pin version that performs the basic function plus off-hook multiplex control, and the 22-pin MC14418 is the full-featured device that contribues most to design simplification, lower parts count and lower costs.

The MC14418 provides a simple, unique addressing capability that allows the use of a completely parallel back plane in a channel group of PCM Codec-based equipment. It also has additional control bits for the performance of three user-programmed system functions. These might be ring enable and power down, or receive tone/data control. A reset pin which may be used for the ring trip function is also provided.

Both TSACs include chip select and clear-to-send signals for further system design simplification. The metal gate CMOS technology is used to insure maximum reliability, which enhances the increased system reliability obtained by reducing your parts count.

For years we've been supplying the telecom market with pulse converters (MC14408/09), tone encoders (MC14410), key-pad-to-binary encoders for telephone dialers (MC14419) and cross point switches (MC142100/5100).

Introduction of the TSAC family following our earlier Codec (14404/06/07) and matched Filter families (MC14413/14), with planned introduction of SLIC (MC3419) and time slot interchange (MC145420) circuits later this year, is testimony of Motorola's commitment to serving the telecommunications industry with the highest quality, innovative products.

Check ☐ J for information.

Motorola's full service MOS Hi Rel line now features memories.

The full service MOS Hi Rel product line of Motorola's MOS Integrated Circuit Division now features NMOS memories in addition to logic from CMOS gates to NMOS microprocessors.

Whether it's dynamic and static RAMs, binary ROMs or EPROMs, all are screened to MIL-883. We've standardized our Hi Rel memory numbering system, too, for easy ordering.

Nineteen CMOS gates, flip-flops, buffers and counters are QPL listed Part I. The entire standard CMOS family is available processed to MIL-883, Class B, method 5004 100% processing/qualifications and QCI per method 5005.

The 14000 and 14500 Series CMOS are available over the full MIL temperature range. Custom mask-provided circuits, both metal and silicon gate, can be produced over the same range.

And, don't forget that the MC6800 8-bit MPU and the key M6800 family peripherals are processed to MIL-883, Class B. These are IMHz devices that operate over the military temperature range.

Motorola Hi Rel NMOS Memories

−55°C to +125°C

STATIC RAMs
MCM2114BVBA45
MCM2114BVBA25
MCM21L14BVBA45
MCM21L14BVBA25
MCM6810BJBA

BINARY ROMs
MCM68316BJBA
MCM68332BJCA
MCM68364BJCA

−55°C to +110°C

DYNAMIC RAMs
MCM4027BEBB25
MCM4027BEBB20
MCM4116BEBB25
MCM4116BEBB20

−55°C to +100°C

EPROMs
MCM68708BJBC
MCM2708BJBC
MCM2716BJBC

−55°C to +85°C

DYNAMIC RAMs
MCM4027BEBD25
MCM4027BEBD20
MCM4116BEBD25
MCM4116BEBD20

MIL-883 processing available for all speeds @0°C to +70°C.

Check ☐ K for information.

XORmacs.™ Advanced support for the 16-/32-bit MC68000.

Motorola's EXORmacs is the new, advanced development ystem that brings minicomputer ower to support of the state-of-e-art MC68000 16-bit microocessor.

And it's time to order. The C68000 is readily available in oth chip form and in the '68000 esign Module configuration.

Getting the most out of a high chnology microprocessor like e MC68000, with its 32-bit ternal features, takes an equally rward looking development ystem, and EXORmacs is the only nswer.

EXORmacs is the new generaon 16-/32-bit multi-user system at incorporates state-of-the-art ardware architecture with adanced software and self-test apability.

The shipped configuration ses four of the 15 available EXORacs motherboard slots and erves a single user. The MPU odule has the MC68000 MPU nd clock system, with a fouregment memory management nit and diagnostic firmware.

The debug module includes ACSbug™ firmware to help implify system debug. The intelgent floppy disk controller odule and a 128K dynamic emory module with parity complete the system.

VERSAbus™ is the new-genration system bus for EXORmacs hat has been carefully planned s the industry standard for suporting 16-/32-bit microprocesors in multi-user and multiple rocessing architectures.

It supports a wide variety of -bit, 16-bit and 32-bit microproessor architectures with higheed data rates, and provides a lexible, economical architecture leal for industrial control, comnunications or general business pplications. VERSAbus is equally repared for future MPU-based ystems.

Very fast cycle time, asynchroous bidirectional operation, MA capability, seven-level riority interrupt control, fiveevel daisy chained operation and bus arbitration are just a few VERSAbus features.

The EXORmacs operating system is a multi-tasking, multiprogramming system which uses a real-time executive.

Advanced EXORmacs development software includes a PASCAL compiler and a powerful symbolic debugger called SYMbug.™

System peripherals are part of the complete EXORmacs system, too. The floppy disk is a dualdrive, double-sided single density unit providing a megabyte of storage. The line printer provides 132 column, 180 cps upper-and lower-case hard copy for the system. A Motorola EXORterm™ 155 intelligent CRT station rounds out the EXORmacs peripheral system.

Comprehensive EXORmacs support ranges from the user system emulator (USE) through items like universal I/O modules and a VERSAbus Adapter module, to training, field service and complete documentation.

It's all EXORmacs, the total new generation development system that takes you into the future, now.

Check ☐ L for information.

Analog Micromodules meet real-world requirements

Motorola's Micromodule™ family is designed to make real-world system design with board-level modules just as easy and cost effective as possible.

Because a lot of that real world is analog, there's a complete complement of analog I/O modules in the Micromodule family.

You select the right A/D or D/A module for your requirements from among the six basic analog types available, hook them up, add a little software code and your system is ready to run.

Analog inputs and outputs are easily interfaced to your microcomputer system. Inputs range from low-level thermocouple (millivolts) to high level (volts), and outputs can be either high-level voltage or current.

ANALOG MICROMODULE FEATURES

High-Level Analog-to-Digital Modules
- 8-, 16-, 32-channel input
- 2.5 V, 5 V, 10 V full scale
- 12-bit resolution
- Resistor/software gain options

Low-level Analog-to-Digital Modules
- 1- and 16-channel input
- 25 mV to 80 mV full scale
- 16-bit resolution
- On-board thermocouple linearization
- Cold-junction compensation

High-Level Digital to Analog
- One-to-four channel output
- 2.5 V, 5 V, 10 V full scale
- 4 to 20 mA full scale

Motorola's Micromodule family is the versatile, powerful method for putting together the ready-to-run system you need, digital and analog.

Check ☐ M for information.

53-channel CATV amps push more programs through your cable

Motorola's taken the pressure off the systems operator with introduction of the MHW4171/4172, 53-channel CATV trunk amplifiers offering 18 more channels than previous types. Designed for 40-400 MHz applications, the units offer power gain of 17 dB over the entire band.

They utilize the same, reliable, Nichrome, all-gold-metallized thin-film construction as our 35-channel units which have totalled millions of hours of trouble-free usage. The family consists of a push-pull stage with a pair of cascodes (common emitter with common base) for a total of four transistors and two transformers, a bilfilar transformer at the input and a trifilar at the output.

And Motorola uses unique flux-free component-attach, stress-relieving final assembly and transformer-pad pretinning fabrication techniques for utmost reliability.

You'll find the units designed to provide the best compromise of ruggedness and electrical performance. They're 100% tested to DC current, RF gain, input and output return loss, IMD, XMD at both ends, composite and three-channel triple beat and NF . . . all at 100° C case which serves as an effective burn-in.

Extensive testing, including temp cycling over a -60° to 125° C range, has been performed over a total of 1,750,000 hybrid-hours without one failure or degradation. Details available on request.

Typical performance specs of the '4171 and '4172 at 46 dBmV include, respectively, IMD of -65 and -72, XMD_{53} of -59 and -62 and TB_{53} of -55 and -58.

100-249 prices for these new industry standard-bearers are $41.25 and $45.75.

Check ☐ N for information.

64K RAM technology boosts memory systems

The most advanced 64K NMOS RAM technology is available at the board level now from Motorola Memory Systems.

Our standard DEC* add-in mer ory boards for the PDP*-11 and LSI-11 are 64K RAM compatible, wi larger configurations taking advan tage of the Motorola 64K MCM666 dynamic RAM.

When fully populated with our state-of-the-art 64K RAMs, the MMS1119 add-in board for PDP-11/04, 11/34 and 11/60 machines packs a full megabyte of memory. A 512K-byte version with the 64K is also available.

The MCM6664 also beefs up ou MMS1102 add-in systems for the LSI-11 to 128K byte and 256K byte capability.

Both the MMS1119 and MMS1102 add-ins are still availabl in smaller configurations that use our 16K RAMs. The MMS1119 wit standard 16Ks comes in 256K byte 192K bytes and 128K bytes. The MMS1102 is available in 64K, 32K and 16K byte offerings.

Motorola 64K RAM technology i also available to CUSTOM memory customers. We combine the latest i RAM technology with our many year of system design and testing expertise to supply specialized custom systems.

We'll take whichever memory chi technology you require for your special application and turn it to reality, in less than six months.

*Trademark of Digital Equipment Corporation

Check ☐ P for information.

Coupon missing? Get information on any of the advertised products and systems by contacting your Motorola sales office or authorized Motorola distributor, or by writing Literature Distribution, Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036.

TO: Motorola Semiconductor Products Inc., P.O. Box 29012, Phoenix, AZ 85036.

3 ED

Innovative systems
through silicon.

Please send me product information on:

☐ A. Intelligent Peripheral Controller
☐ B. Standard CMOS Logic
☐ C. Switching Power Supply
☐ D. LM117, 3-Terminal Voltage Regulator
☐ E. Data Encryption Device
☐ F. Straight Shooter Fibre Optics
☐ G. Mil Zener
☐ H. Schottky Rectifier
☐ J. Time Slot Assigner Circuit - TSAC
☐ K. Hi-Rel MOS
☐ L. EXORmacs
☐ M. Analog Micromodules
☐ N. 53-Channel CATV Amps
☐ P. Memory Systems
☐ Q. 5 V EPROMs

☐ Send me the Motorola Memory Data Book.
My check or money order for $3.00 is enclosed.

☐ Please have a salesman call. PHONE ______________________

Name ______________________

Title ______________________

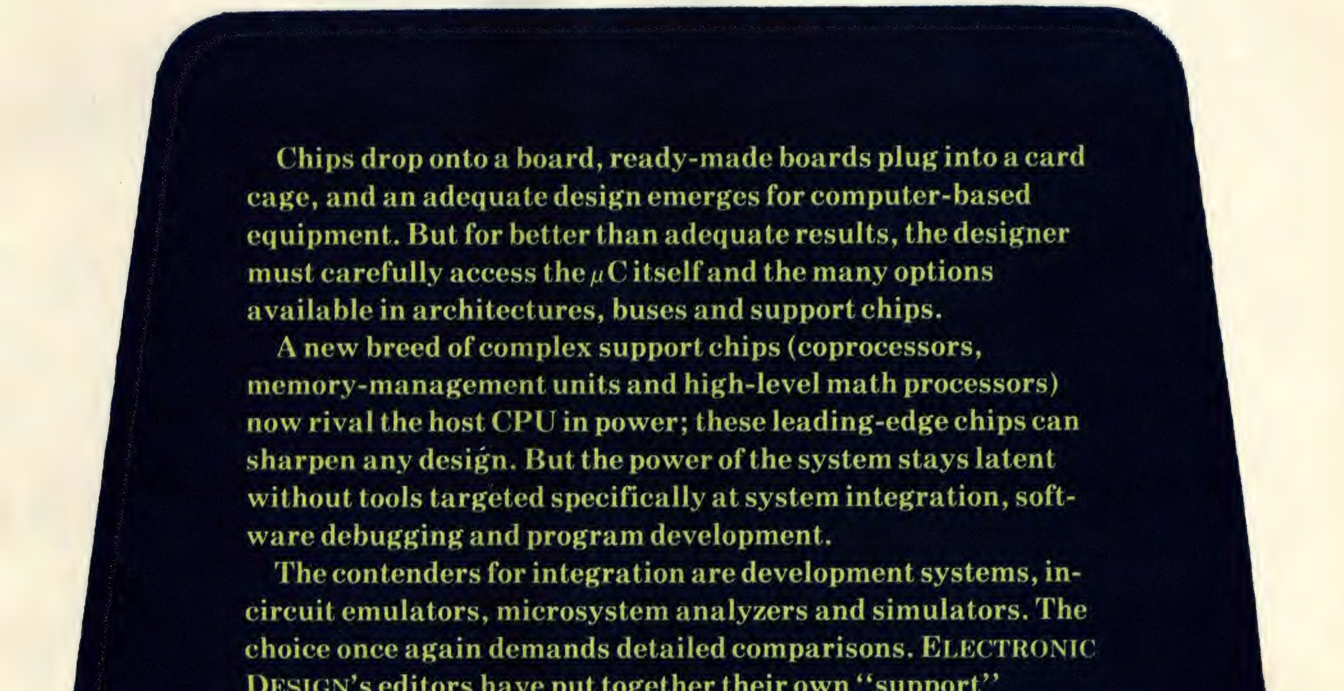
Company ______________________

Address ______________________

13444 PRINTED IN USA 4/80 IMPERIAL LITHO B85573

Technology

Which μC? Which bus? Which development tool?



Chips drop onto a board, ready-made boards plug into a card cage, and an adequate design emerges for computer-based equipment. But for better than adequate results, the designer must carefully access the μC itself and the many options available in architectures, buses and support chips.

A new breed of complex support chips (coprocessors, memory-management units and high-level math processors) now rival the host CPU in power; these leading-edge chips can sharpen any design. But the power of the system stays latent without tools targeted specifically at system integration, software debugging and program development.

The contenders for integration are development systems, in-circuit emulators, microsystem analyzers and simulators. The choice once again demands detailed comparisons. ELECTRONIC DESIGN's editors have put together their own "support" package, to provide all the vital information.

Low-cost hard disk computers are here and field proven

11 megabytes of hard disk and 64 kilobytes of fast RAM in a Z80A computer for under $10K. Two floppy drives, too. Naturally, it's from Cromemco.

It's a reality. In Cromemco's new Model Z-2H you get all of the above and even more. With Cromemco you get it all.

In this new Model Z-2H you get not only a large-storage Winchester hard disk drive but also two floppy disk drives. In the hard disk drive you get unprecedented storage capacity at this price—11 megabytes unformatted.

You get speed—both in the 4 MHz Z80A microprocessor and in the fast 64K RAM which has a chip access time of only 150 nanoseconds. You get speed in the computer minimum instruction execution time of 1 microsecond. You get speed in the hard disk transfer rate of 5.6 megabits/sec.

EXPANDABILITY

You get expandability, too. The high-speed RAM can be expanded to 512 kilobytes if you wish.

And the computer has a full 12-slot card cage you can use for additional RAM and interface cards.

BROADEST SOFTWARE SUPPORT

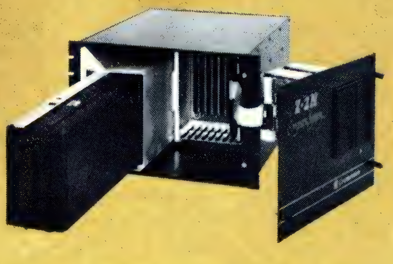
With the Z-2H you also get the broadest software support in the microcomputer field. Software Cromemco is known for. Software like this:

- **Extended BASIC**
- **FORTRAN IV**
- **RATFOR (RATional FORtran)**
- **COBOL**
- **Z80 Macro Assembler**
- **Word Processing System**
- **Data Base Management**

with more coming all the time.

SMALL, RUGGED, RELIABLE

With all its features the new Z-2H, including its hard disk drive, is still housed in just one compact cabinet.



Hard disk drive at lower left can be interchanged just by sliding out and disconnecting plug. Seven free card slots are available. Z-2H includes printer interface card.

Included in that cabinet, too, is Cromemco ruggedness and reliability. Cromemco is time-proved. Our equipment is a survey winner for reliability. Of course, there's Cromemco's all-metal cabinet. Rugged, solid. And, there's the heavy-duty power supply (30A @ 8V, 15A @ +18 V, and 15A @ −18V) for circuitry you'll sooner or later want to plug into those free card slots.

SEE IT NOW

Last summer we told you this new Z-2H would be a smash. And it is. So see it at your dealer's now. Have him put you in touch with a user—there are lots of them because Cromemco has been delivering for months. See for yourself how pleased our users are.

PRESENT CROMEMCO USERS
We've kept you in mind, too. Ask about the new Model HDD Disk Drive which can combine with your present Cromemco computer to give you up to 22 megabytes of disk storage.

Cromemco
incorporated
280 BERNARDO AVE., MOUNTAIN VIEW, CA 94040 • (415) 964-7400
Tomorrow's computers today

CIRCLE NO. 44

System performance hinges on CPU architecture...

Although microprocessors have developed from two roots, controllers (Fig. 1) and general-purpose minis (Fig. 2), no two μP schematics seem to share even a basic architecture. So how does the designer pick the right chip? Let the application point the way to the best architecture.

Consequently, before even looking at the bus sizes or registers, the user must decide what's most important: speed or flexibility, price or addressing range, I/O or number crunching, fast interrupts or programming ease.

As a first step, the target system's software should be drafted—this is best done in a higher-level language whose machine code can then be disassembled automatically by a development system. In most applications, 80% of a μP's work is determined by 20% of the code, and this 20% must be identified. It's important to know:

- What role will interrupts play?
- How frequent are subroutines and other jumps?
- How will parameters be passed?
- Are *reentrant* procedures necessary?
- How much arithmetic is involved?

Without this early attention to detail, there is no way to estimate even the basic throughput of a chip. Mere clock speed counts for little, if one chip takes five cycles and another only one for the same operation.

Inadequate throughput, especially in a real-time application, can be disastrous. In a conventional Von Neumann machine, instructions and data share the same memory and travel over the same "data" bus while another bus carries the address to the memory location that contains the needed data. The width of the data bus is generally a μP's most important criterion because it determines both numerical accuracy and the maximum instruction "menu." The width of the address bus, on the other hand, determines the μP's direct addressing range.

In a small controller, a 4-bit data bus provides a choice of only 16 "values," e.g., the number of lights to be turned on or off. Similarly, a 4-bit address bus provides only 16 programming steps—probably enough for a traffic light. As bus sizes have been growing, such restrictions have become less important. But overdesign—selecting a bus that's too big—is costly, and will get more so as today's 8 and 16-bit buses turn into 24 or 32-bitters (Fig. 3).

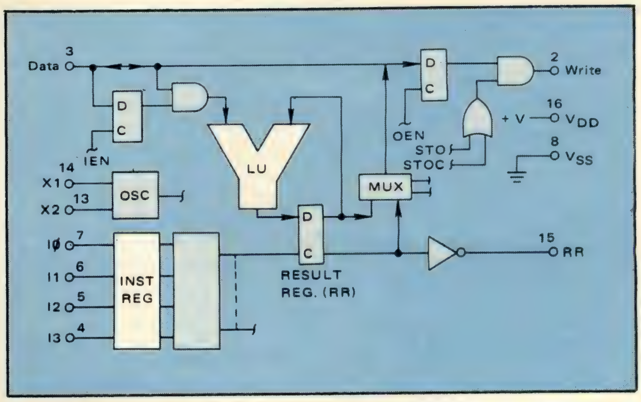
One more bus

In addition to the address and data buses, μCs need a collection of control lines that interface the processor with other subsystems. Sometimes called a control bus, it too, has been growing with μC complexity. As "wide-body" buses are spreading, bus size has a dramatic impact on chip—and system—architecture.

One reason to watch the bus lines is that they consume chip connections. Three 16-bit buses, a clock input and the power-supply voltage alone need 51 pins—a problem if the package has only 40. That difficulty is resolved easily by letting two buses timeshare the same connections, but there's a price to pay: greater circuit complexity and (often) slower speed.

On the other hand, when the data bus isn't wide enough, instructions and their operands don't fit side-by-side, and several transfers (fetches) from memory become necessary. Obviously, speed will suffer.

Borrowing a page from their mini forebears' manuals, many high-end μPs fetch the next instruction



1. The evolution of μPs from controllers with *random logic* is crystal-clear on Motorola's MC14500B 1-bit chip. Its architecture, though primitive, includes all the major components of standard μPs.

Max Schindler, Software Editor

while the ALU works on the current one. But while this "look-ahead" feature boosts throughput, it requires additional circuitry and therefore additional chip space, which may better be occupied by, say, more memory or I/O.

Random logic hangs in

It's this limited real estate, moreover, that is fueling the never-ending battle between random logic and microprogrammed architecture. Random logic can cram more functions into the same area than a microcoded structure. It's also faster. For this reason, Intel's 8086 may derive primary control from a 21-bit-wide ROM, but where speed is critical, random logic is employed. The Motorola 68000 has a two-tier ROM: A narrow (10-bit), high-level control word from the first ROM is decoded into about 70 control signals in a second ROM—again a compromise.

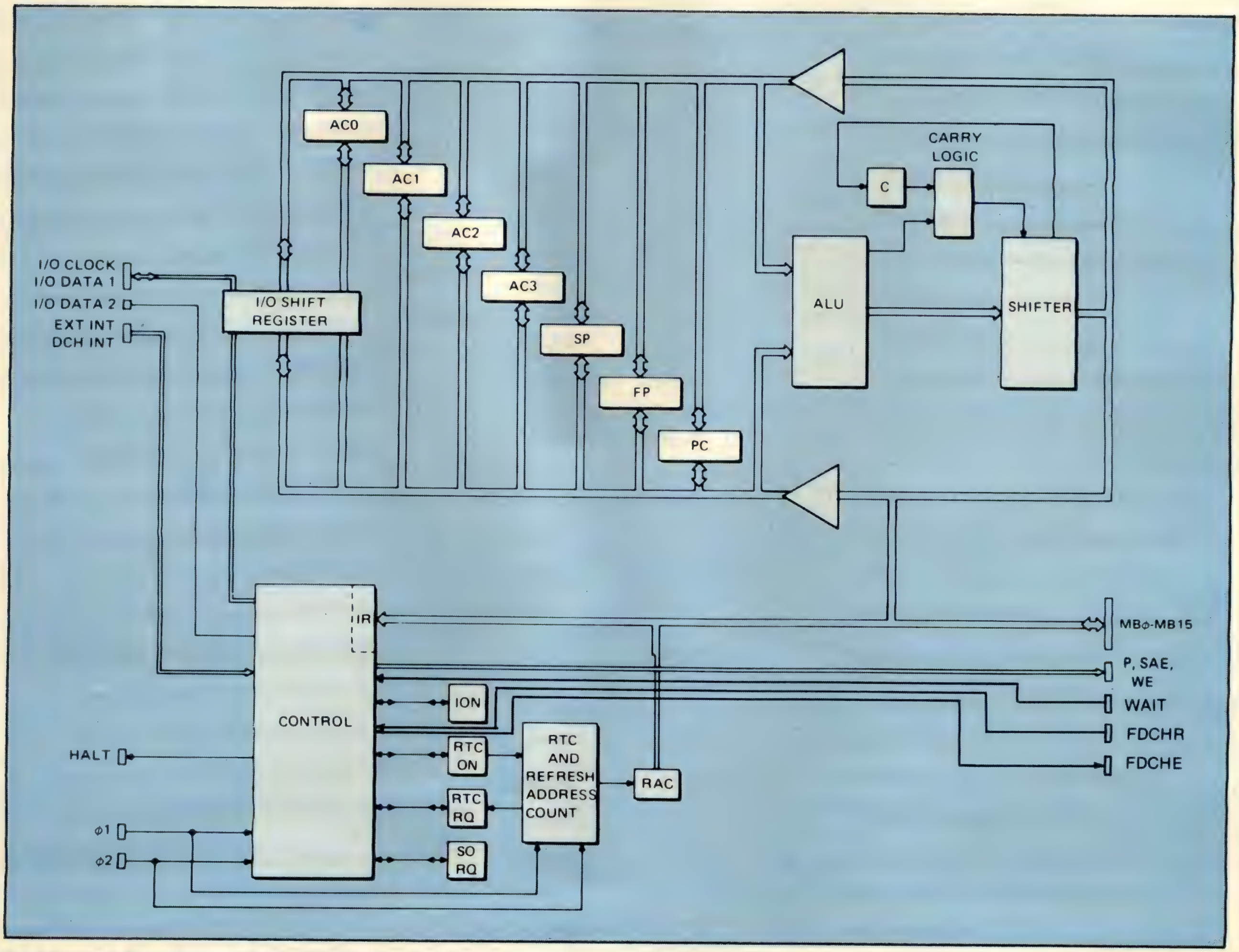
Microcode, on the other hand, offers a clean, symmetrical instruction set and a broad range of addressing modes, which can boost program efficiency. In fact, the ability to combine the most memory-efficient addressing modes with the most time-efficient CPU operation can reduce overall system cost substantially in code-intensive situations.

Still, the time lost in control-store decoding often negates the software gains microprogramming has to offer. So, compromise remains the rule of the day. The Table summarizes how different manufacturers tackle the problem.

Registers—pro and con

And the user's dilemma continues. Some μP makers emphasize the richness of their register repertoire (Fig. 4), while others boast that their chips don't even need an accumulator. Both claims can be legitimate: A choice of registers (including accumulators) may greatly enhance the capability of smaller, controller-derived μPs, whereas direct transfer of operands from source memory to ALU to destination memory can save valuable time in problem solving.

A processor's housekeeping chores always require



2. Although Data General's mN602 has its roots in the Nova microcomputer, the chip's architecture still resembles that shown in Fig. 1. But accumulators and pointer registers (highlighted) replace the flip-flops.

Abridged dictionary for computer architects

Associative memory: See "Content-addressable memory."

Bank switching: To increase the size of a processor's address space, bits controlled by the operating system select memory banks.

Bit slice: A processor building block. Connected in parallel, bit slices perform operations on data words of any length.

Cache: A small, high-speed memory buffer between the processor and main memory where often-used data are duplicated. Most often uses content-addressable registers.

Content-addressable memory: A memory that is addressable by its contents rather than by location. Often used in segmented systems to store recently used segment base addresses.

Context switching: Certain information that belongs to a task, user or process must be saved when a task's execution is suspended. Some systems automatically save the current instruction address and the processor status in memory when an interrupt occurs; others contain multiple register sets that can be swapped quickly.

Control store: Microprogram storage (usually very high-speed ROM/PROM) in a microprogrammed processor system.

DMA: Direct Memory Access. The system processor is placed in a wait mode while another device transfers data to or from memory at a high rate.

Exception: An irregular condition (arithmetic overflow, interrupt, power failure) that is resolved by the exception handler.

Immediate addressing: An addressing mode containing the operand within an instruction.

Indexed addressing: The effective address is calculated by adding the address data contained in the instruction to the "offset" stored in an index register. Extremely useful for subscripted variables.

Indirect addressing: The address contained in the instruction points to a memory location that contains the effective address. The processor reads the data in the specified memory location, then performs a second memory access.

Interrupt: A signal that causes a processor to suspend current execution and to transfer control to special interrupt-handling software (see "Exception"). Vectored interrupts use a set of memory locations with the addresses of interrupt-service routines to which control is transferred.

Logical addressing: Unlike absolute addressing, it is independent of the physical memory structure of a given system. During execution, the logical address is translated (by hardware or software) into the physical address.

Memory-mapped: I/O devices may be accessed as if they were memory locations. Since peripheral control registers, mapped into memory locations, may be either read-only or write-only, reads and writes at the same memory location may have no connection to each other.

Microcode: *Horizontal* code increases the number of simultaneous functions by adding control fields to each microinstruction, thus widening the control word. *Vertical code* reduces microinstruction width by decreasing the number of simultaneously performed functions, thus reducing execution speed.

Microprogram: Sequence of microinstructions for a microprogrammed processor (e.g., designed from bit-slice components). A regular control structure in ROM replaces random-logic control elements to control the operation of the ALU. A machine (or macro) instruction is composed of many microinstructions.

Pipelining: Most often, the overlapping of fetch and execute cycles within a processor. After the fetch unit has passed a decoded instruction on to the execution unit, it places the next one in the instruction queue.

Position-independent code: Executes independently of its physical memory location. Usually the code contains only relative transfer instructions; otherwise, all addressing is done by base registers.

Program status word (PSW): Register that contains processor-status information resulting from the previous operation (carry, borrow, overflow, zero flags, interrupt status).

Reentrant code: Code executed simultaneously by more than one software module, each of which must maintain its own data area. If one software module is interrupted while executing reentrant code, the interrupt service may execute the reentrant code, even though the first module has not been completely executed.

Register addressing: Addressing mode using a register as the effective address of one of the operands, mainly to shorten instruction size.

Relative addressing: Permits addresses to be specified relative to the address of the current instruction (program counter), e.g., to provide position independence.

Stack: A data-storage structure in which new items are added to the top of the existing stack in a LIFO (last-in, first-out) fashion. Often used for subroutine linkages. A register contains the address of the current top-of-stack.

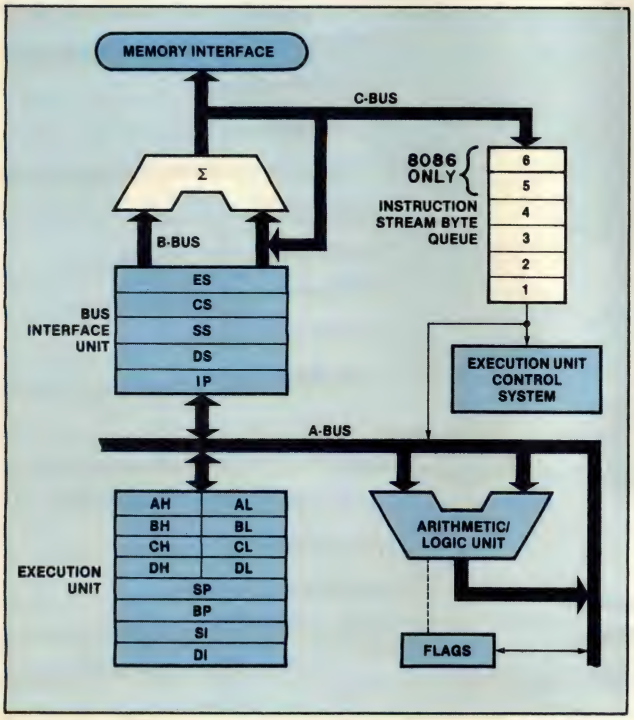
Zero-address instruction: Contains no addressing information; it's implied that the accumulator or the stack stores the result.

some memory, regardless of where it is located. One register must, for instance, keep track of the program count. When a current program module is stopped by a subroutine or an external interrupt, data must be preserved until the old program resumes. How this is done depends on the frequency and nature of program disruptions.

When nested or reentrant procedures prevail, it may be better to push layers of information into a practically unlimited stack in main memory. For multitasking programs, on the other hand, exchanging register banks in one fell swoop can speed up the processor's throughput.

In the 8086, registers have been assigned to special functions, based on an analysis of programs primarily written in high-level languages (ELECTRONIC DESIGN, March 1, 1980, p. 97). As a result, fewer instruction bits are needed than in the common registers in the Z8000 or 68000; at the same time, however, the 8086 architecture is less transparent. In addition to its execution unit, the 8086 contains a second processor, the bus interface unit (BRU), which takes care of the fetch-ahead instruction queue.

Texas Instruments' 9900 family, on the other hand, has adapted the memory-to-memory technique from its 990 minicomputer series, while retaining general-purpose and index registers. In fact, it boasts a special communication register unit (CRU), which is bit-addressable up to 4096 bits. This proves to be a great asset to handling a wide I/O range in control applications—including d/a conversion.

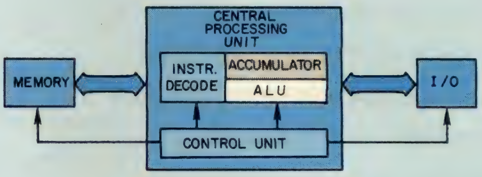


3. **The 8086's processing power stems from an architecture more sophisticated than even a conventional mini's. In addition to the ALU, an asynchronous second processor operates through its own bus, which feeds the instruction queue (highlighted).**

John Von Neumann's curse?

After completing Eniac, John Von Neumann was convinced that the next generation of computers would have to be programmed electronically rather than with patch cords. More importantly, he decided that instructions would be stored in memory exactly like data. When the renowned Maniac became operational in 1952, Von Neumann's approach was apparently vindicated. But some computer architects blame his concept for many of the shortcomings in today's computers. And alternate architectures are appearing in the form of distributed array processors, data-flow machines and associative memory.

The Von Neumann machine consists of four essential components: processor (highlight), memory, input/output and control circuitry. The processor—at its most elementary, an arithmetic logic unit (ALU) —operates on one or two operands fetched from memory and puts the results in a special register, the accumulator. Operands can come directly from memory, but more often they are first stored in registers within the CPU. Both approaches can be found in μPs.



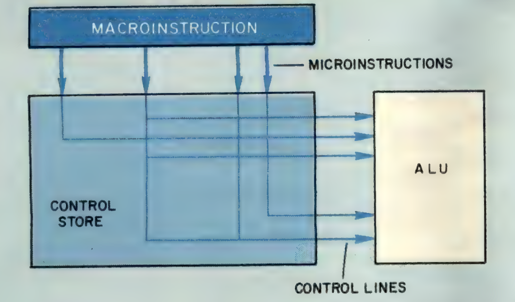
Instructions, on the other hand, can never enter the ALU directly; they must first be decoded. The resulting sequences of ZEROs and ONEs mean different things to different CPUs—in fact, even in the same machine their meaning depends on the status of certain control lines.

A simple ALU is just an adder that can also perform logical AND, OR and perhaps XOR. By setting some lines high or low, these simple instructions set ALU switches via hard-wired ("random") logic. The register-based ALU (often called RALU) gains more versatility, but as the number of instructions grows, not only does the decoding logic become quite complex, but its rigidity prevents future changes or

Two heads—better than one?

While a single powerful processor may be the most convenient route to get a μC off and running, many applications will benefit if several processors can share the load. Often, special-purpose processors are available that have been designed specifically to expansions to the instruction set.

Microcoding offers an alternative. Here, instructions are decoded in a ROM (the control store) and the whole instruction set can be replaced simply by reprogramming the control store. This technique has become standard on minis and mainframes, but because it requires more chip space, different μPs use different degrees of microcoding.



Each bit in microcode represents one specific choice (AND/OR, add/substract, register/memory) and is called a microinstruction. Logically enough, the complete set of microinstructions is a macroinstruction, more often simply called op code.

The expression "macro" has, unfortunately, found another application. Macro capability in an assembler, for instance, means that the user can write assembly-language "subroutines," (more accurately, functions) that are executed whenever the macro shows up in the code. The "macro feature" is unrelated to architecture.

Beyond Von Neumann

Von Neumann's architecture sounds simple; back in the pioneering days of the "electronic brain," the demands boiled down to one function: Perform difficult and voluminous mathematical calculations. But today's computers are expected to do word processing, process control, computer-aided design, data-base management—practically anything but hard labor.

No wonder that new architectures have been cropping up in mainframes and minis to match the hardware to the job. Though delayed by cost and size limits, such innovations are slowly spilling over into μCs. Intel's 8048, now four years old, is not a Von Neumann machine, because it separates data and instructions. The 8086, with its two processors, takes a similar tack.

Processor/memory interfacing in general is a weak spot of the traditional architecture, and alternate solutions keep cropping up. Cache memories, used widely to boost throughput, may seem traditional enough, but they include the most prominent departure from the Von Neumann concept—content-addressable memory.

Since data are copied into cache, according to their frequency of use, the CPU never knows exactly what data are where. With both data and their labels in associative registers, a search for the label will produce the data. Today's μCs have no specific cache memory, but as on-board RAM becomes more abundant it may well be used in this manner.

Another attempt to increase throughput is by directly executing high-level languages. Western Digital's Pascal Microengine is a step in this direction, but it uses intermediate code. Since direct execution must be line by line, structured programming poses a problem for such machines, but Basic lends itself readily to direct execution. National Semiconductor's 8073 implements direct execution for NBasic, a subset of the language.

With the growing use of μCs for business applications, more and more designers must tackle nonnumeric processing. Based on the comparison of operands rather than their addition (as is the Von Neumann machine), nonnumeric processing does not proceed in such an easily defined way as mathematical calculations, and the traditional architecture's pigeonhole memory is an obstacle.

Associative memory, which has decision-making power built into it, could offer a solution, were it not for its excessive cost for all but the simplest data bases. But by storing related data closely together, the random nature of associative memory can be replaced by the concept of context addressing, which uses inexpensive sequential memory.

---

relieve the CPU of well-defined tasks.

A case in point is Intel's 8089 I/O processor (IOP), designed to work with the 8086 and 8088 CPUs. IOP and CPU communicate by sending each other messages via system memory, but are otherwise autonomous. Since the two I/O channels of the 8089 have their own registers, they can work independently from each other.

The IOP's instruction set handles data transfer (in the DMA mode at up to 1.25 Mbytes); arithmetic and logic operations; bit, byte and word manipulation; and process control. In a typical configuration, the 8089 might handle disk-to-memory transfers over the main bus, while a local bus takes care of a floppy disk, CRT and keyboard control—all under the IOP's own program.

Other dedicated processors span a wide range of applications; these include AMI's S2811 signal-processing peripheral, AMI's 9511 and 9512 math chips and Intel's 2920. The 2920 is a stand-alone μP, but accepts up to four inputs, analog as well as digital.

Given a choice of several competing, but func-

Architectural features of representative microcomputers

Manufacturer	Type	Number of bits			Pipelining	Registers	Microcoded
		Data	Instructions	Addresses			
Advanced Micro Devices	29116	16	16	N/A	Yes	32	Yes
Data General	mN602	16	16	15	No	7	Yes
Digital Equipment Corp.	LSI-11/2	1-32	16-48	16	N/A	8	Yes
	LSI-11/23	1-32	16-48	8	N/A	8	Yes
Hewlett-Packard	1000-L	16	16	16	N/A	2	Yes
Intel Corp.	8086-2	8-16	8-56	20	Yes	14	Some
	8089	8-16	16-48	20	No	16	No
Intersil	HM6100	12	12	12	N/A	6	Yes
Mostek Corp.	3870	8	8-32	12	No	64	No
Motorola	6809	8-16	8	16	No	9	No
	68000	1-32	16-80	24	Yes	17	Yes
National Semiconductor	16032	32	8-32	24	Yes	8	Yes
	8073	8	8-24	16	No	8	No
	NSC800	8	8-24	16	No	22	No
RCA Semiconductor	1802	8	8	16	No	16	No
Texas Instruments	9900	16	16-48	15	No	14	Yes
Zilog	Z8	8	8-24	8-16	No	144	No
	Z8000	16	16-64	23	Yes	20	No

Manufacturer	Comments
Advanced Micro Devices	100-ns execution (bipolar, high-density); user tradeoff; speed vs instruction width.
Data General	Serial I/O accepts 100-ft runs in noisy environment.
Digital Equipment Corp.	All general-purpose registers can be accumulators; unlimited vectored interrupt.
	256-kbit addressing accommodates more powerful programs.
Hewlett-Packard	SOS technology.
Intel Corp.	256 vectored interrupts, bus 8/16 bits; 64-bit math available with 8087 chip.
	2-channel I/O processor for 8086 and 8088; bus interface handles combinations of 8 and 16-bit peripherals.
Intersil	First 128 addresses serve as stack; popular for data acquisition.
Mostek Corp.	Executes instruction set of F8; lines TTL-compatible; on-board 8-bit prescaler and test logic; several variants.
Motorola	Position-independent code via 9 addressing modes.
	32-bit internal architecture, 192 interrupts, 2-tier ROM, 16 M6 direct addressing.
National Semiconductor	Also works as stack machine; transparent slave operation.
	Interrupts & DMA, real-time OS in Basic (about 6000 lines).
	Bus-compatible with 8085, but P²CMOS provides NMOS speed.
RCA Semiconductor	1804 is faster version with 64-byte RAM, 2-k ROM.
Texas Instruments	Derived from 990 mini: I/O memory-mapped or via CRU (20 lines).
Zilog	On-board timers unburden CPU; 6 interrupts, slave for Z8000; power-down mode.
	User and system stack pointer separate; integral memory management by 8010 chip; 3 interrupts.

Features raising throughput	Special software features
Most instructions need only 1 cycle; register banks reduce memory operations.	High-speed bit manipulations; targeted for controller use.
High-bandwidth DMA, compact code; stack suitable for saving local variables.	Compatible with Nova software; simple, symmetrical instruction set.
Much-used data kept in registers; fast interrupt service, 12 addressing modes.	Efficient compilation by clean architecture; no special instructions for memory-mapped I/O.
Floating-point arithmetic in-line, up to 20 times faster than by software.	LSI-11 family compatible with PDP-11 software.
Separate I/O processor offloads CPU, simplifies DMA; distributed processing.	Multiprocessing software to fit 1000-L is compatible with other HP-1000s
16-bit hardware mult/div; register set optimized for HLL; string handling, multiprocessing.	PL/M-86 for efficient code, structured programming enhanced by addressing modes.
DMA transfer rate 1.25 Mbyte/s; each channel has an independent register set and instruction pointer.	Instruction set permits use as file and buffer manager. Soft error recovery; special assembler available (MD312).
Operand, address combined in 1 word; direct-memory operation, 2 pages accessible.	Compatible with PDP-8 software; page-relocatable, 128 words each.
On-chip scratchpad of 64 x 8 bits used as registers; 60% of instructions are 1-byte; on-board timer.	Compact code, autoincrementing and decrementing for many memory and register instructions.
Nonmultiplexed buses save buffers. Fast DMA, memory-mapped I/O.	Registers and addressing optimized for HLLs (Fortran, C, Pascal); supports reentrant code.
Register/register instructions: 0.5 μs/word; parallel pipeline; automatic interrupt nesting, traps.	Instruction set optimized for HLLs; supervisor mode for multiple tasks and users.
No data-type restrictions due to symmetrical memory/memory architecture.	Compact code from HLLs, efficient compilation, virtual machine support.
Links with 8070 to speed critical routines; few external fetches; interruptible.	Direct execution of N-basic by resident ROM interpreter-also assembly.
Fast context switching for interrupts via dual register set; 5 vectored interrupts.	Instruction set of Z80; special instructions for fast data movement, I/O.
Cycle stealing for DMA reduces execution interference.	SEP instruction provides fast subroutine calls. Compact code.
Separate buses, context switch for interrupt and procedure response.	Expandable instruction set for new hardware, software functions; 4096 I/O bits.
"Work spaces" (16 registers ea.) for fast context switch (interrupts, routines); no accumulator.	60% of instructions are 2 bytes; source/destination addresses; software-selected bus and port configuration.
Block-I/O; 1-64 kB in single instruction; much-needed data available in general registers.	Register set optimized for compiler use, protects CPU. Address space ideal for structured programming.

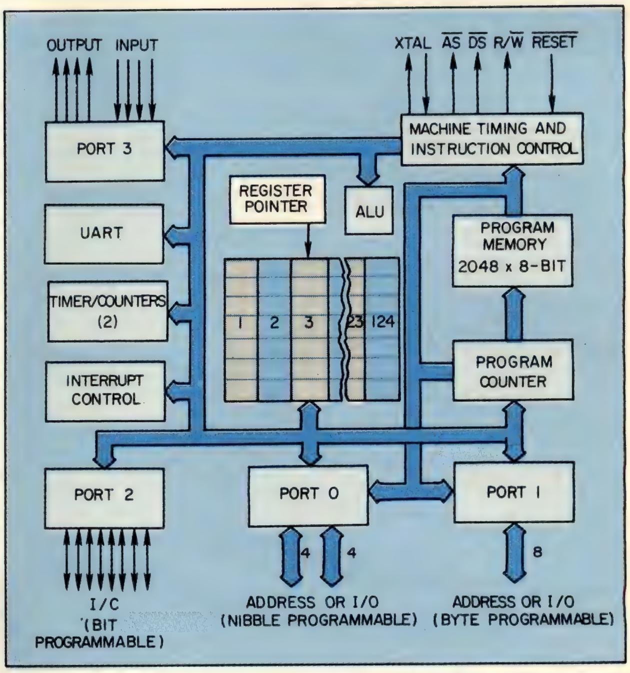
tionally equivalent μCs, the designer's selection may well be based on the peripheral chips offered with the CPUs. Auxiliary chips include, in addition to those already discussed, floppy and hard-disk controllers, memory managers, signal processors, GPIB interfaces, CRT and graphics chips, and more.

Mini or micro?

At the high end of the processor spectrum sits a group of chips, developed for the most part to simulate minis. The biggest attraction here is their ability to use existing minicomputer software but at microcomputer prices. The Intersil 6100, for example, runs on PDP-8 software—because of its 12-bit word size, an established favorite for data-acquisition tasks.

Digital Equipment's LSI-11/2 is, of course, patterned closely after the PDP-11 family, while the newer LSI-11/23 also does floating-point arithmetic in-line, up to 20 times faster than under software. Similarly, the Data General mN602 thrives on Nova programs and preserves that mini's high-bandwidth DMA. And a new chip, to emulate the Eclipse line, is already chafing at the bits.

Although Motorola's 68000 is not patterned after a specific mini, its internal organization certainly



4. Register-oriented processing typifies the Z8 architecture. Whole banks, of 16 registers each, permit fast context switching—a big asset for subroutine and interrupt servicing.

shows which way it's headed. In fact, it is designed like a 32-bit machine with separate supervisor and user modes—an attractive feature for multiuser/multitasking applications. Soon the question will no longer be "Micro or mini?", but "Micro or mainframe?"

Other routes to the future

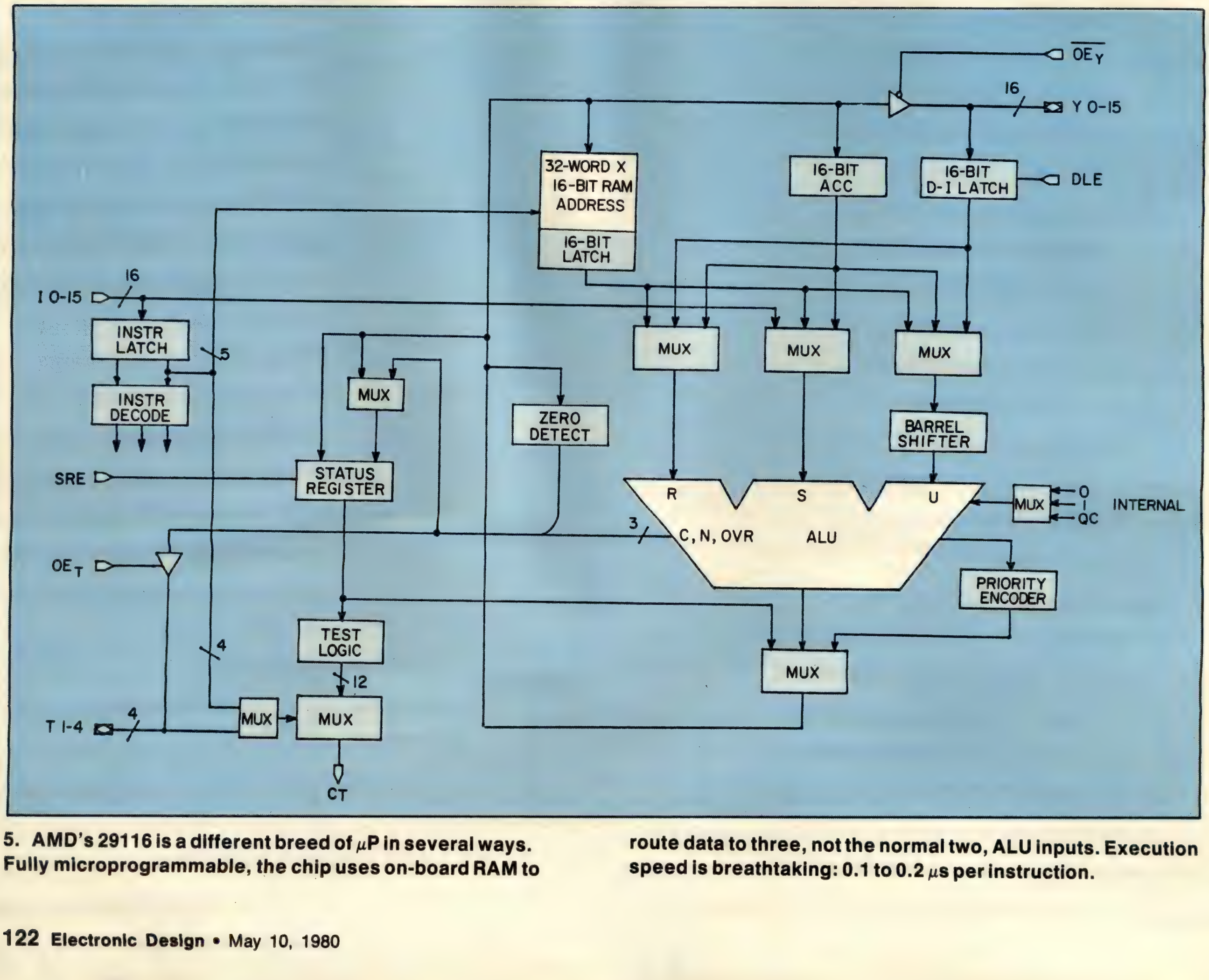
The incessant drift toward μCs with mainframe features is, however, a mixed blessing. Unlike μPs, μCs can be designed as excellent controllers or as fine number crunchers, but rarely as both. The MC6801 may be an exception—it can actually rearrange its own configuration: the multiplexed partial-decode ROM locations 20 to 7F and 0100 to F7FF can be accessed by external memory as well by the ALU. In its μP configuration, the 6801 thus retains the flexibility of a pure processor, while working as a self-contained μC.

An entirely different route to future microsystems is bit-slice machines, which can be (and have been) built to emulate almost anything from the simplest controller shown in Fig. 1 to a complex mainframe. Fairchild Camera's F100220 family of 8-bit processor slices include many mainframe features, plus the ability to add 64 bits in only 35 ns. Bit slices of such versatility may well turn into the mainstream of tomorrow's μC technology, but they can hardly fit into do-it-yourself computer design.

Finally, architecture remains a decisive factor for chip selection, though not the only one. Manufacturing technology still plays a role. Although CMOS has been gaining steadily, bipolar technology has its place. AMD's 29116, for instance, executes all instructions in 100 ns—a throughput gain of one or two orders of magnitude over many μCs. (Fig. 5) Another example of special capabilities is Motorola's 1170 PMOS controller, which can drive vacuum-fluorescent displays directly.

Some chips, for instance in the AMI2000 family, or Motorola's 6805, have built-in timers and drivers —an important saving for control applications. TI's TMS-1000 family of 4-bit controllers can readily be custom-designed during final production steps for a wide range of consumer and industrial applications from games to smart instruments. In volume, this chip has been sold for as little as \$1.50.

As the Table shows, the other end of the spectrum includes processors like the AMI6809, the HP 1000-L, the 8086, the 68000, the NS16000 family, the Z8000 and others, all of which have special provisions for multitasking or multiprocessing.□



5. **AMD's 29116 is a different breed of μP in several ways. Fully microprogrammable, the chip uses on-board RAM to route data to three, not the normal two, ALU inputs. Execution speed is breathtaking: 0.1 to 0.2 μs per instruction.**

ADDRESSABLE I/O SYSTEMS FROM OPTO 22

(PB 16S1)

(PB 16P1)

Huntington Beach, California . . . Opto 22, originators of the industry standard I/O system, announces the second generation in I/O Systems in both serial and parallel configurations.

SERIAL ADDRESSABLE RACK (PB 16S1)

Communication with multiple input/output stations.
32 station address capability per serial loop.
Up to 16 power I/O modules per station.
Switch selectable baud rate.
Opto 22 provided firmware includes message protocol, event counter, self test, watch dog timer and more.
Plug in modules provide choice of:
1. 20 Ma Current Loop.
2. RS 422 Balanced Differential Drivers and Receivers.
3. Optically Coupled Drivers and Receivers.
4. RS 232

PARALLEL ADDRESSABLE RACK (PB 16P1)

Bidirectional Communication with input or output modules.
64 station address capability.
Up to 16 Power Input/Output modules per station.
50 Conductor Daisy-Chain cable connects all racks to host controller.
On-board station address select switch.

15272 Relay Circle, Huntington Beach, CA 92649
(714) 892-3313

opto 22

Another Opto 22 product available for immediate shipment.

You're looking at a variety of Elco two-piece pc connectors. After you put one on the job, you don't have to keep remembering to check the reliability of the connection. Nothing much is apt to disturb it. Not in most applications.

That's because these two-piece, metal-to-metal pc connectors feature Elco's Varicon™ contacts. Their hermaphroditic fork-like design provides four mating surfaces that wedge together under spring-loaded pressure. Even after years of service and thousands of mating and unmating cycles, a gas-tight connection with low contact resistance is maintained.

The 8223 plug (shown above with wire) comes with a .100" × .100" dual-row square grid and mating receptacle for 1/16", 3/32", and 1/8" thick P.C. board. It's available with 24, 48, 72, or 96 contacts with a choice of terminations: wire wrapping, pc solder tail, wire hole, and wire crimp. Polarity and keying are built into the body to prevent mismating. It's MIL-C-55302 QPL approved.

Other Elco two-piece connectors for 1/16" and 3/32" thick P.C. cards are supplied in popular sizes (6 to 96 contacts), and with popular spacings (.050" or .100" dual row staggered, and .100" single row). They're all competitively priced and promptly available from connector-oriented distributors.

For the names of Elco distributors near you and a copy of our Two-piece pc Connector Catalog, write to ELCO Connector Division, Huntingdon Industrial Park, Huntingdon, Pa. 16652. Tel. 814-643-0700. TWX 510-691-3117.

G+W **Elco Corporation**
a Gulf + Western manufacturing company

9E-9103

CIRCLE NO. 46

...But the right bus evokes the system's best

Bus structures bind together the elements of a microcomputer and form the internal and external data pathways; therefore, they greatly influence the system's performance. Even from that basic description, radically different buses have evolved; in particular, the STD bus from Pro-Log, the Multibus from Intel, the Z-bus from Zilog, the MOTEL from Motorola and Intel, the LSI-11 bus from Digital Equipment Corp. and the TM990 bus from Texas Instruments. Problems inevitably arise when the products of different manufacturers must employ one bus. Solutions are held out by standardization, by modifications of bus layout (to resolve such limitations as shallow bit lengths and insufficient interrupt levels) and by software packages that will allow system designers to integrate hardware onto and off the master bus. In the meantime, the differences among the buses are most apparent in:

- Addressing lines—access to memory locations and I/O data bus lines; master processor arbitration; master-slave or interprocessor communications
- Interrupt levels—response time to service interrupts; the number and types of interrupts
- I/O—methods of interface (DMA, block, cycle-stealing or transparent modes)
- Bus memory timing—memory cycles, DMA cycles or memory-mapped I/O
- Architecture—address, control or data bus lines for 8, 16, 24 or 32-bit microcomputers.

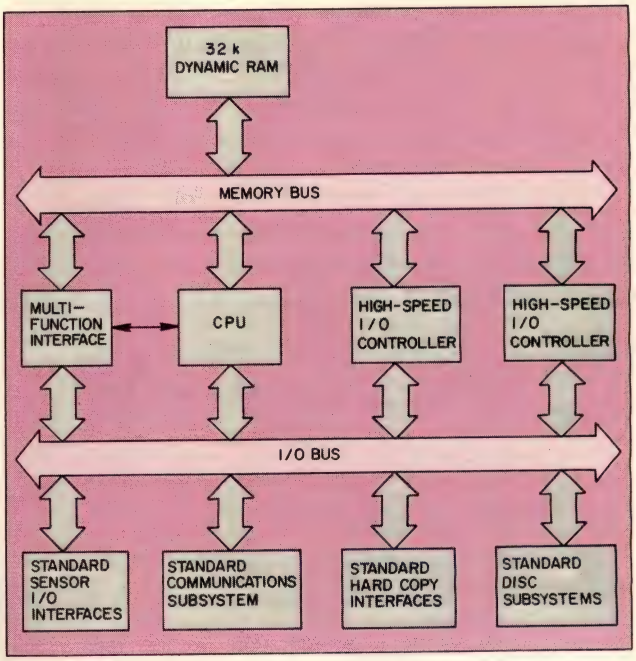
Two major μP families, Motorola's 6800 and Intel's 8080, demonstrate the incompatibility that exists between various buses. The Motorola and Intel buses have some similarities, and both peripheral and memory parts are available from many suppliers for each μP family; yet, parts designed for one μP will not connect directly to the other.

Like the other major semiconductor manufacturers, Intel and Motorola have pursued a standardized bus to support their μPs. These efforts toward standardization currently emphasize 16-bit microprocessors, with effective addressing ranges of 32 bits.

Motorola and Intel will soon announce the MOTEL bus (MO for Motorola and TEL for Intel). It will allow users to plug memory and peripheral circuits directly into the bus of microprocessors from either family. The MOTEL concept is specifically aimed at LSI, where pin counts are limited and multiplexing can save the situation. Without adding pins, the MOTEL circuit allows one peripheral or memory IC to be used with multiple processors. The processors must accept a multiplexed bus.

Among the first beneficiaries of the MOTEL bus concept will be CMOS 8-bit μPs; for example, Motorola's MC146805, Intersil's 80C48, National's NSC800 and RCA's 80C85. Because all four use a multiplexed bus, the newest generation of CMOS peripherals can take advantage of the pin savings—stimulating the creation of more industry-standard CMOS peripherals and μP-compatible memories.

Other efforts toward standardization are apparent in the work of the IEEE standards group, Pro-Log's STD manufacturers group (STDMG) and Zilog's approach to its Z-bus.


32 k
DYNAMIC RAM
MEMORY BUS
MULTI-FUNCTION INTERFACE
CPU
HIGH-SPEED I/O CONTROLLER
HIGH-SPEED I/O CONTROLLER
I/O BUS
STANDARD SENSOR I/O INTERFACES
STANDARD COMMUNICATIONS SUBSYSTEM
STANDARD HARD COPY INTERFACES
STANDARD DISC SUBSYSTEMS

1. In the MP200 from Data General, the CPU communicates with both RAMs and slower memory elements over the 16-bit-wide memory address/data bus; with I/O controllers over the microNOVA bus; and with high-speed I/O controllers over both the microNOVA I/O bus and the memory bus.

Leonard Yencharis, Computers Editor

The Z-bus family from Zilog unites Zilog's Z8/Z8000 family of components. The multiplexed bus structure provides for three types of interaction: transfer of addresses and data between components, shared bus control of the data transfer portion of the bus, and a resource control for allocating extensive resources among multiple CPUs. The Z-bus also has an interrupt mechanism for signaling conditions between components.

Each Z-bus works with a single CPU which has a default control of the data-transfer portion of the bus and which receives interrupts and bus-control requests from peripherals and requestors. Any of the three Z-bus CPUs available will work with all Z-bus compatible peripherals and memory: the 16-bit Z8001, the 16-bit Z8002 (both capable of 32-bit operations) and the 8-bit Z8.

The two 16-bitters execute the same instruction set: The Z8001 manipulates a 23-bit address and the Z8002 manipulates a 16-bit address. The Z8 has 256 bytes of on-board RAM, 2048 bytes of on-board ROM and built-in peripherals (an asynchronous serial transceiver, counter-timers and parallel ports). It can also be configured to access external memory and uses 8, 12 or 16 bits of address.

In general, bus architecture can be multiplexed, like the Z-bus, MOTEL bus, or Data General's microNOVA bus (Fig. 1), or nonmultiplexed. The multiplexed bus saves on pin count; each pin handles more than one function. Nonmultiplexed buses are used primarily for dedicated systems, since each pin has a dedicated function.

In multiplexed bus architecture, the address information and data information are on the same lines but separated from each other in time. The bus carries either data or addresses, depending on the state of a μP control line.

Nonmultiplexed buses are synchronous or asynchronous. In synchronous architectures, address and data lines are separate and independent. The system assumes that all the μPs and peripherals that operate on the system clock are fast enough to complete their read and write operation within the clock's cycle period.

In addition to the system clock, address lines and data lines, the bus usually contains control lines, power and ground lines and other lines for properly managing and operating the system.

Nonmultiplexed buses that are asynchronous do not require the system components to operate within the cycle period of the system clock. Additional control lines inform the controlling μP when a read or write has completed, while the μP waits for the peripheral to complete its cycle.

Interrupt levels and priorities

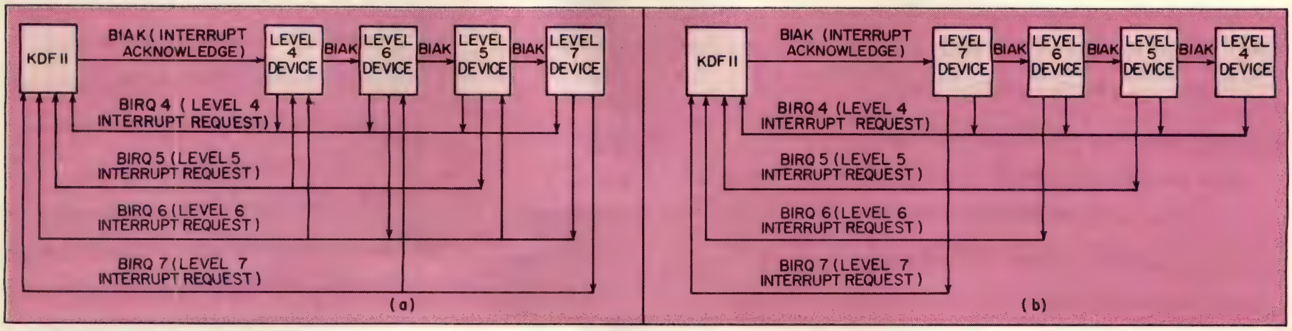
Interrupts allow the processor to take action outside of its normal programmed sequence. Because the need for interrupts is time-related, the interrupt scheme must provide quick responses and service.

Each of the major buses employs a different interrupt scheme. The proposed logical standards for the Pro-Log STD bus (which will affect interrupt signals, timing and signal names) give consideration to two types of interrupts: vectored and polled.

In vectored systems, hardware is enabled by the INTAK signal, which tells the processor directly or indirectly which source caused the interrupt. A prerequisite for this scheme is hardware priority arbitration for maximum speed.

With polled interrupts, the processor does not generate the interrupt acknowledge signal (INTAK); rather, a programmed interrupt service routine interrogates the possible sources of the interrupt. The routine determines which sources originated the interrupts and establishes the priority of multiple requests.

The STD proposal fully supports polled interrupts by requiring that the Interrupt Request (INTRQ) line be capable of wired-ORing. To poll, the CPU reads I/O ports of memory locations associated with the interrupting hardware. The STD-bus signal that


KDF II
BIAK (INTERRUPT ACKNOWLEDGE)
LEVEL 4 DEVICE
BIAK
LEVEL 6 DEVICE
BIAK
LEVEL 5 DEVICE
BIAK
LEVEL 7 DEVICE
BIRQ 4 (LEVEL 4 INTERRUPT REQUEST)
BIRQ 5 (LEVEL 5 INTERRUPT REQUEST)
BIRQ 6 (LEVEL 6 INTERRUPT REQUEST)
BIRQ 7 (LEVEL 7 INTERRUPT REQUEST)
(a)
KDF II
BIAK (INTERRUPT ACKNOWLEDGE)
LEVEL 7 DEVICE
BIAK
LEVEL 6 DEVICE
BIAK
LEVEL 5 DEVICE
BIAK
LEVEL 4 DEVICE
BIRQ 4 (LEVEL 4 INTERRUPT REQUEST)
BIRQ 5 (LEVEL 5 INTERRUPT REQUEST)
BIRQ 6 (LEVEL 6 INTERRUPT REQUEST)
BIRQ 7 (LEVEL 7 INTERRUPT REQUEST)
(b)

2. With the four-level interrupt scheme of the LSI-11/23, peripheral devices can be set up as position-independent or position-dependent. If peripheral devices are placed in the backplane in any order, they must send out interrupt requests and monitor high-level request lines (a). If the devices are position-dependent (b), they must be inserted with the highest priority device closest to the processor. This configuration is simple to implement.

controls the ports and memory also services the interrupt.

Polled interrupts are inherently slower than vectored interrupts, and signal timing is not critical or dependent on the type of processor. Vectored interrupts can be made even faster by minimizing or eliminating the processor's involvement in servicing the interrupt mechanism (no interrupt service routine). However, the hardware then becomes more closely tied to the processor type.

To handle interrupts, the bus needs a priority scheme. The priority-interrupt controller manages priority through a patch network, discrete interconnect or software control.

In a serial-priority scheme, each peripheral needing interrupt priority must have logic ready to service the interrupt. The logic that serves one processor is usually incompatible with any other processor; thus, peripheral cards designed for serial interrupt are processor-dependent.

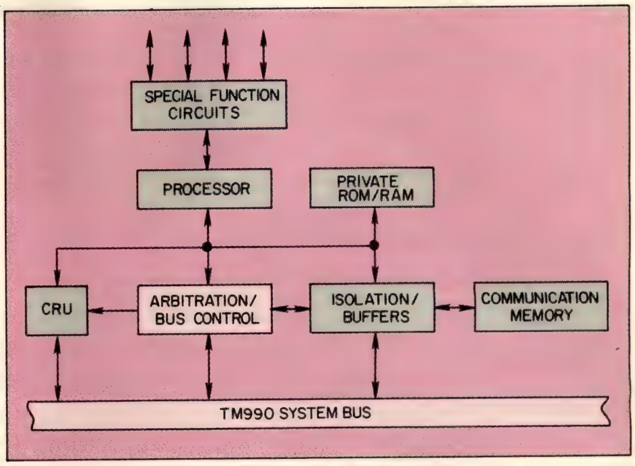
In a parallel priority scheme, the processor depends on one parallel-priority card, and not on the cards for each peripheral. The priority-interrupt card is a modular function that can be tailored to an individual processor; the peripheral cards can be processor-independent. A parallel-priority scheme can be implemented on the STD bus.

Vectored interrupts

Interrupts on Intel's Multibus signal lines are implemented in another way. Nonbus-vectored (NBV) and bus-vectored (BV) interrupts permit only one master to respond to a given Multibus interrupt.

The NBV interrupts are handled on the bus master. The vector address is not transferred by the Multibus, but is generated by the interrupt controller on the master and then transferred to the processor over the local bus. The slave modules that generate the interrupt can reside on the master module or on other bus modules. In the latter case, the slave modules use the Multibus interrupt-request lines (INTO/INT7) to transfer their interrupts to the bus master. When an interrupt-request line is activated, the bus master performs its own interrupt operation and processes the interrupt.

The BV interrupts transfer the vector address along the Multibus from the slave to the bus master, using the INTA/ command signal. When an interrupt is requested, the control logic on the bus master interrupts its processor. The processor generates the INTA/, which freezes the state of the interrupt logic on the Multibus until priority is resolved. The bus master also locks the Multibus to guarantee back-to-back cycles. After the INTA/, the bus master's interrupt logic puts an interrupt code on the Multibus address line (the highest-priority active interrupt-request line). The Multibus can support bus masters that generate either two or three INTA/s, but not both. The Multibus can support NBV interrupts at the same time as BV interrupts.



3. In multimaster systems, like the TM990 system, the allocation of resources is critical. No two (or more) processors may share a single resource at the same time. Electrical bus-mastership is maintained for entire instructions by software indicators.

In still another bus, that of DEC's LSI-11, the interrupt capability allows any I/O device to suspend the program being executed temporarily and to divert the processor so that it can service the requesting device (Fig. 2). The processor inputs a vector from the device to start the service routine (handler). Hardware fixes the device vector (and the device register address) at locations within a designated range (below location 001000). The vector is used as the first of a pair of contiguous addresses.

The content of the first address is read by the processor and forms the starting address of the interrupt-handler. The content of the second address is a new processor status word (PS). This new PS can raise the priority level, preventing low-level interrupts from breaking into the current service routine.

Control is then returned to the interrupt program when the interrupt-handler is ended. The original or interrupted program's address (PC) and its associated PS—which were stored on a stack—are restored by a return-from-interrupt (RTI or RTT) instruction at the end of the handler. The stack and the interrupt scheme permit interrupts within interrupts (nested interrupts), depending on the PS.

Two methods of originating interrupts are open to LSI-11 processors. Interrupts can be generated within the processor. Called traps, these interrupts are caused by programming errors, hardware errors, special instructions and maintenance features.

Interrupts can also be generated by the LSI-11 bus, using a protocol that has three phases: interrupt-request; interrupt acknowledge and priority arbitration; and interrupt-vector transfer.

The interrupt-request phase begins when a device meets specific conditions; for example, the device is "ready," "done" or an error has occurred. The interrupt-enable bit in a device status register is set. The device then imitates the interrupt by asserting the appropriate interrupt-request lines. In the LSI-11, BIRQ4L—the lowest hardware-priority level—is asserted for all interrupt requests to ensure compatibility with previous LSI-11 processors. The level at which a device is configured must also be asserted. A special case exists for level 6 and level 7 devices.

The interrupt-request line remains asserted until the request is acknowledged. Then the bus establishes the priority of the request through either distribution arbitration or position-defined arbitration.

In distribution arbitration, priority is implemented in logic on the interrupting device, based on request-priority information on the bus. When devices of equal priority level request an interrupt, priority is given to the device electrically closest to the processor.

By contrast, position-defined arbitration determines priorities solely by a device's electrical position on the bus. The closer a device is to the processor, the higher its priority.

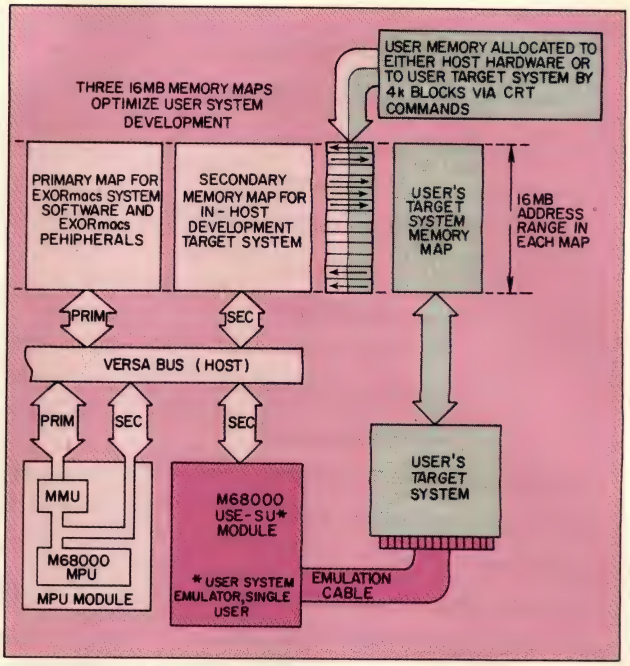
During the interrupt-acknowledge and priority-arbitration phase, the processor acknowledges interrupts under the following conditions: The interrupt priority of the 11/23 device is higher than the PS <07:05>; the processor has completed instruction execution; and no additional bus cycles are pending.

For systems with high-speed peripherals needing better software performance, the LSI-11/23 can distinguish between four levels of interrupts. The four-level scheme permits both position-independent and position-dependent configurations.

The position-independent configuration allows peripheral devices to be placed in the backplane in any order. The level-4 request is always asserted by a requesting device, regardless of priority, to allow compatibility when an LSI-11 or LSI-11/2 processor is in the same system. If two or more devices of equally high priority request an interrupt, the device closest to the processor wins arbitration.

The position-dependent configuration is easier to implement. The only constraint is that the peripheral devices with the highest priority must be located closest to the processor. The remaining devices are placed in the backplane in decreasing order of priority. Each device asserts its own level and level 4; higher level request lines are not monitored.

Yet a third method for handling interrupts is that used by the TM990 system (Fig. 3). The bus accommodates two fixed and fifteen general-purpose interrupts. The two fixed interrupts, PRES and RESTART, cannot be masked by any processor. PRES is the highest priority interrupt in a TM990 system; it serves as a system reset. The fifteen general-purpose interrupts are maskable under software control. The interrupts are prioritized in descending order; INT1 is highest and INT15 is lowest. A system module generating a general-purpose interrupt must hold its interrupt line active until the processor acknowledges receipt of the interrupt by addressing the module.


THREE 16MB MEMORY MAPS OPTIMIZE USER SYSTEM DEVELOPMENT
USER MEMORY ALLOCATED TO EITHER HOST HARDWARE OR TO USER TARGET SYSTEM BY 4k BLOCKS VIA CRT COMMANDS
PRIMARY MAP FOR EXORmacs SYSTEM SOFTWARE AND EXORmacs PEHIPHERALS
SECONDARY MEMORY MAP FOR IN-HOST DEVELOPMENT TARGET SYSTEM
USER'S TARGET SYSTEM MEMORY MAP
16MB ADDRESS RANGE IN EACH MAP
PRIM
SEC
VERSA BUS (HOST)
PRIM
SEC
SEC
MMU
M68000 MPU
MPU MODULE
M68000 USE-SU* MODULE
* USER SYSTEM EMULATOR, SINGLE USER
EMULATION CABLE
USER'S TARGET SYSTEM

4. The VERSAbus presently handles up to seven priority interrupt levels, offers daisy-chained bus arbitration for up to five levels and provides as many as 50 peripheral I/O lines. The bus can handle 16-bit μPs, plus 8, 16 and 32-bit data transfers at 5-MHz rates from μPs with 8 to 32-bit architectures.

The TM990 system bus provides three modes of I/O interfacing: through DMA, memory-mapped I/O and the communications register unit (CRU), which is the simplest of the three. With CRU, data transfers between a processor and the I/O device take place 1 to 16 bits at a time, on serial data lines; I/O transfers can take place on different lines under software control. The CRU is a bit-oriented I/O system and can be input only, output only and input/output.

Bus memory timing

Interrupts aside, timing constraints for memory accesses, whether normal memory cycles, DMA cycles or memory-mapped I/O cycles, must be given special consideration. System applications requiring large read/write memory capacities will probably use dynamic RAM, which has greater bit packing density than static RAM and saves on both cost and space. However, dynamic RAMs must be refreshed periodically to avoid the loss of stored data.

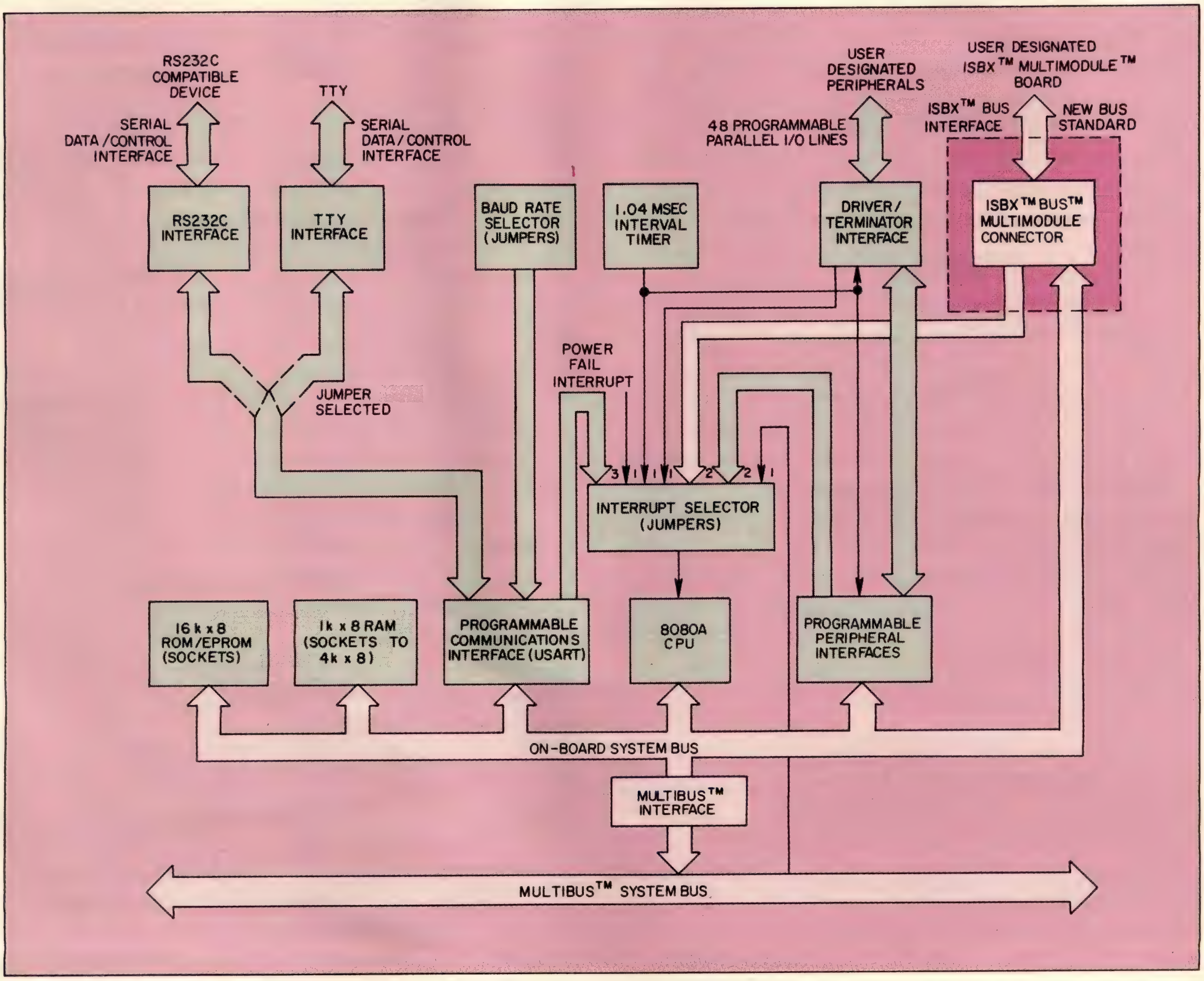
The refresh interval is determined by the maximum refresh time needed by the memory circuits. A refresh cycle is initiated by a timer or a memory board. When a processor or DMA device starts a memory-access cycle to the dynamic RAM address space, it has no guarantee that the dynamic RAM will be ready. Each wait for the RAM lengthens the memory cycle.

Refresh is handled efficiently by cycle stealing or transparent refresh. A cycle is stolen only if a memory-access request occurs while a refresh is in progress and only if the request is to the address space of the microcomputer being refreshed.

In the transparent-refresh mode, refresh occurs only when the processor is not accessing memory. Thus, cycles do not have to be stolen. Transparent refresh is made possible by synchronizing the refresh cycle to the CPU memory cycle.

The use of transparent refresh should be carefully evaluated by the system designer. In some cases, transparent refresh will yield an improvement in system performance. However, where there is a high level of DMA activity or slow access to dynamic RAMs (i.e., if Wait states are in use) or both, only marginal improvement may result from transparent refresh. Transparent refresh may also increase power dissipation, since refreshes are executed at a faster rate than that actually required by the memory devices.

The TM990 system uses a combination of cycle stealing and transparent refresh. The number of nonmemory cycles may not be sufficient to prevent refresh violations with transparent refresh. Consequently, the dynamic RAM modules of the TM990 can revert to the cycle "steal" mode of operation whenever a refresh violation occurs. The memory uses the READY signal to extend the requested memo-


RS232C COMPATIBLE DEVICE
TTY
SERIAL DATA/CONTROL INTERFACE
SERIAL DATA/CONTROL INTERFACE
USER DESIGNATED PERIPHERALS
USER DESIGNATED ISBX™ MULTIMODULE™ BOARD
48 PROGRAMMABLE PARALLEL I/O LINES
ISBX™ BUS INTERFACE
NEW BUS STANDARD
RS232C INTERFACE
TTY INTERFACE
BAUD RATE SELECTOR (JUMPERS)
1.04 MSEC INTERVAL TIMER
DRIVER/TERMINATOR INTERFACE
ISBX™ BUS™ MULTIMODULE CONNECTOR
POWER FAIL INTERRUPT
JUMPER SELECTED
3
1
1
2
2
1
INTERRUPT SELECTOR (JUMPERS)
16k x 8 ROM/EPROM (SOCKETS)
1k x 8 RAM (SOCKETS TO 4k x 8)
PROGRAMMABLE COMMUNICATIONS INTERFACE (USART)
8080A CPU
PROGRAMMABLE PERIPHERAL INTERFACES
ON-BOARD SYSTEM BUS
MULTIBUS™ INTERFACE
MULTIBUS™ SYSTEM BUS

5. The iSBX bus interface reduces latency timing problems because the iSBC modules (from Intel Corp.) are tightly coupled to the on-board CPU through the bus. The interface can support serial I/O (RS-232 or RS-422/449 operation), DMA and, in some cards, 32-bit single-precision and 64-bit double-precision arithmetic and data manipulation commands.

ry cycle sufficiently for completion of refresh.

The 32-bit microprocessors that loom in the future also require buses. Some of these buses will be new, and some will build on current bus systems.

Motorola provides for future μP systems through its EXORmacs development system, which is now geared toward the company's MC68000 16-bit microprocessor. Inside the system is a 5-MHz bus called VERSAbus—which consists of 32 address and 32 data line (Fig. 4). Memory-management logic and bus-arbitor modules share the bus action with the 68000. An entire 16-bit, 16-Mbyte system with full priority interrupt and bus arbitration can be implemented on the 8 × 9.25-in. boards of the VERSAbus. The clock rate is expected to increase from the present 5 MHz to 10; ultimately priority levels will increase from the present seven of 16.

I/O expansion

Zilog's Z-bus will also handle a 32-bit microprocessor in the future. The most important consideration for such expansion is multiplexing of addresses and data on the same lines. This data-transfer function is primarily a cost-saving device, but it should also provide substantial benefits for I/O accesses. Pin minimization will keep packages to a reasonable size; fewer bus drivers and buffers will be needed; board-area will be conserved; and smaller backplanes and connectors will result.

One advantage of multiplexed address and data lines for I/O programming is that the internal registers of a peripheral can be directly addressed without additional pins. This pin savings becomes more and more useful as peripherals proliferate and become more sophisticated, requiring access to as many control registers and nonbus pins as possible.

Another pin conservation measure is "encoded status." The Z-bus state lines distinguish between three kinds of data transfer on the bus, and give considerable information about each. The information helps to coordinate the activity of support devices, such as memory management or extended processing units.

The British connection

Last October, the Microcomputer Bus Standards Committee (Middlesex, England) reported on the E78 Microcomputer Bus Specification. At that time, boards were already configured with 6800 and Z80 processors and work began with a Z8000 device. Zilog's Z8000 microcomputer board will feature the standard Eurocard size and take advantage of E78 specs: 24 address lines, I/O expansion capability, vector-interrupt, high-priority-interrupt mechanism and 28 bus pins. Daisy-chaining will be permitted for up to three devices.

The possibilities for integrating μP bus structures to the card level are *exemplified* by Intel's iSBX bus (Fig. 5). The SBC complements and enhances Multibus architecture by expanding the system through an additional connector on the host board. In addition to its other Multibus interrupts, the iSBC/10B single-board computer creates a single-level interrupt from 11 interrupt levels. The 80/10B is given a lowest-priority interrupt, so that expansion capabilities do not interfere with normal processing.

Board-level microcomputers and their support equipment must maintain digital communications with each other. To handle the high transfer rates from the bus architecture on the backplane to the communication I/O port on the mainframe, several new techniques are being investigated.

For the asynchronous parallel buses that provide intercommunication between processors, both new chips and new standards for IEEE-488 are pending. Three IC companies have announced chips that will handle this handshaking protocol.

A subcommittee of the IEEE Computer Standards Committee is developing several microprocessor standards, one of which is a proposed backplane bus standard for both 16 and 32-bit μPs. The IEEE working group has decided on a baseline objective: a backplane bus, that can operate up to 20 MHz, includes multiplexed address and data lines and provides for asynchronous subsystems. The committee has decided that the difficulty of synchronizing several subsystems at the bus interface level would preclude a synchronous bus protocol.

The proposal encompasses 16 and 32-bit data paths and 24 and 32-bit address paths, to be supported by the bus. The subcommittee is looking at four configurations: 16-bit data/24-bit address and 32-bit data and address, in multiplexed and nonmultiplexed versions. The subcommittee has concluded that, because of present limitations on program memory (100/kbytes for the 8086 μP) for 16-bit and 32-bit systems (cards), the bus does not have to be a high-speed, multimaster data channel and needs little (if any) instruction fetch and programmed I/O activity.

Other proposals confront the need for several nondedicated control lines and for error detection and split-read capability on the backplane. Split-read increases throughput because a request for a read includes the address of a reader, allowing the bus to be released for the duration of the read access. The proposed bus would transmit over 50 cm.

A bus that can transmit over 30 meters has been proposed (ELECTRONIC DESIGN, Oct. 25, 1979, p. 21). This solid-state version of the Sperry-Univac D-bus would support up to 16 I/O ports. The 8-bit parallel transfer rate would be 1 Mbyte/s, and the 16-bit parallel transfer rate would be 2 Mbytes/s. □

When you need LEDs or more than LEDs...

Dialight is the first place to look. We can help you do more with LEDs . . . because we've done more with them.

Discrete LEDs come in a variety of sizes, shapes, colors (red, yellow, green in clear or diffused), with or without built-in resistors.

Low cost logic state fault indicators for trouble shooting complex circuits. Designed for close density PC board mounting.

High-brightness bi-color LEDs (red/green) suitable for go/no-go situations. Designed with unique lenses for the extra visibility you'll want for your most critical applications.

Snap-in mounting LED indicators reduce labor cost. Available in red, yellow or green with or without built-in resistors.

Whatever you need in LEDs, Dialight's probably got it already. For your free 60-page selector guide and listing of our nationwide stocking distributors, contact us today.

DIALIGHT
A North American Philips Company

Dialight meets your needs.

Dialight, 203 Harrison Place, Brooklyn, N.Y. 11237 (212) 497-7600

CIRCLE NO. 47

Cutler-Hammer H11 limit switches go the distance.

These environmentally-sealed switches could even outlast your product. Every component is MIL-S-8805 approved to assure you of dependable, long-range performance in the harshest environments.

For more information on any product in our full line, contact your Cutler-Hammer Aerospace Products Specialist or distributor—they know your business. And, write for our free catalog. Eaton Corporation, Aerospace Control/Systems Division, 4201 N. 27th St., Milwaukee, Wisconsin 53216.

EATON Electrical/Electronic Control

CIRCLE NO. 48

Facile support chips free up the host CPU...

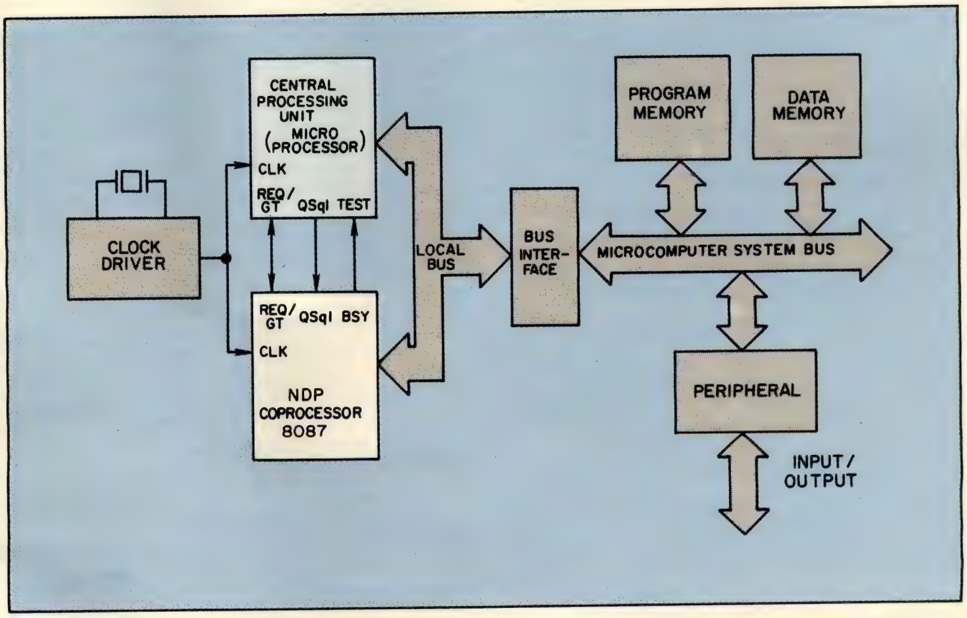
Dave Bursky, Semiconductors Editor

The latest-generation (16-bit) microprocessors sport minicomputer-like architectures—and little room to carry the many random-logic support functions so vital to advanced operations. So it's up to powerful, highly-specialized support circuits to extend processor capabilities to levels approaching those of large mainframes. These circuits make possible such high-level math as floating-point arithmetic, trignometric operations, transcendental calculations and fixed-point operations, as well as memory management to handle the megabyte and larger memory-addressing capabilities of the latest processors.

Starting with the 8086 from Intel (Santa Clara, CA), with its 1-Mbyte address range, the list of new processors needing such functions has grown to include the Z8001 from Zilog (Cupertino, CA), with its 8-Mbyte addressing capability, and the MC68000 from Motorola (Austin, TX), with its 16-Mbyte capability. But then comes National Semiconductor's (Santa Clara, CA) recently introduced NS 16000 family of 16-bit processors. And Intel is hinting at a family of pseudo and full 32-bit μPs. What's more, even older processors such as the TMS9900 from Texas Instruments (Dallas, TX) offer mini-like features—and the 9900's stable of support circuits, already strong, is being enhanced with additional members to bring out even more performance.

Slave support

Several kinds of support circuits can pick up where the processor leaves off. For example, "slave" circuits, one of the earliest concepts, are dedicated functional blocks that operate like a peripheral device. Downloaded by the processor, the slave, such as the Am9511/12 math circuits developed by Advanced Micro Devices (Sunnyvale, CA), often operates ten to 100 times faster than the CPU, interrupting the CPU when the operation is complete so that the CPU can transfer the result back into its accumulator or into a memory location. However, the slave is a handful to control: The programmer must



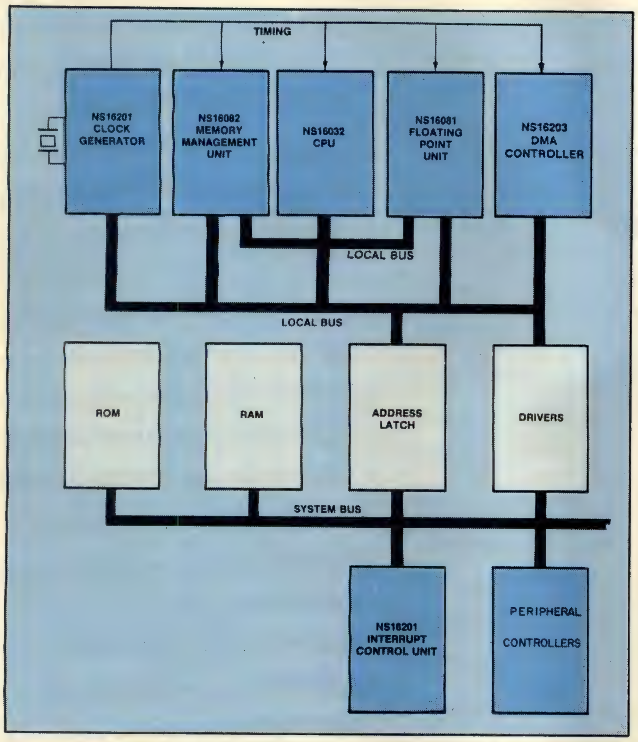
1. Able to share a local bus with the host CPU, a numeric data processor developed by Intel can perform complex math operations in just microseconds. The NDP also shares some of the CPU resources and follows the same instruction stream, reacting to just those instructions intended for it.

keep track of the operation and allow for system interrupts, special I/O routines to transfer the data back and forth, as well as make allowances for the associated overhead.

While, in most cases, the additional work and overhead are well worth the performance boost offered by the slave, a new type of support circuit has emerged that does more than a slave with less hassle. Coprocessors, or extended processing units, as some manufacturers call them, require that the host processor contain special instructions that transfer control without delays to them. But then system throughput and performance increase.

Unlike slave circuits (in the earlier definition of a slave), which are usually down loaded directly from the processor, coprocessors actually make use of some of the CPU's resources and can obtain data directly from the system buses. And while earlier slaves required that the host CPU execute a subroutine to load the information into the proper registers for execution, the later coprocessor slave monitors the instruction flow and, in conjunction with the CPU, loads itself with the necessary data.

When the processing in the slave or coprocessor is finished, both usually interrupt the host CPU. But the slave peripheral requires that the host CPU retrieve the results and then either store or use them. A coprocessor can transfer the results directly to a memory location or to any other device connected to the data bus with the help of the CPU, but without having to funnel the information through the host CPU, thus slowing it down.



2. The NS16081 floating-point math circuit is part of a system National Semiconductor is building with a high-power CPU and intelligent slaves or coprocessors. Plans also include a memory manager, a DMA controller, an interrupt controller and other advanced system support.

Special instructions help

To take advantage of coprocessor capabilities, most of the latest CPUs include special instructions in the command set that permit the processor to perform microprogrammed routines. These routines operate much more efficiently than a macroprogram or subroutine.

Commonly used commands include escape operations, which go by different names, depending on the processor manufacturer. When these commands are inserted in the program flow, they make the processor operate as though the host CPU had the desired operation built in. Activated by the specific escape command, the processor then executes the microcode that causes the proper coprocessor to be activated and loads in the proper information, either from the CPU's registers or directly from the data memory.

If the data are located outside the host CPU, the coprocessor can take advantage of the host's resources, such as registers and program counter, so that it can access the necessary memory locations and obtain or store the data.

Many of the coprocessors are expected to have a chip size that rivals that of the μP itself. The 8087 math coprocessor unveiled by Intel, for example, will have a chip area close to 90,000 mil^2. It will also be able to operate at 5-MHz clock rates, performing calculations such as a temporary real precision (80 bit) multiplication in just 16 μs (Fig. 1).

The circuit divides into two subsystems, one for bus interface and one for floating-point execution. Multiplication, division, square root and remainder operations are contained in a hardware arithmetic module within the chip and are controlled by microcode.

The numeric data processor can operate on seven data types: 16, 32 and 64-bit two's complement integers, 32-bit (real), 64-bit (long real), 80-bit (temporary real) binary floating-point numbers, and 80-bit (18-digit) signed packed BCD integers. Operations performed by the circuit include addition, subtraction, multiplication, division, remainder, square root, transcendental functions (logarithmic and trigonometric), and binary/decimal conversion, all of which will conform with the proposed IEEE floating-point standard.

The 8087 also supports all of the 8086's addressing modes when it accesses the system memory, and results, except for the store operation, are always returned to the chip's stack. Results are correctly rounded according to the proposed IEEE standard, with four rounding modes and three levels of precision control available.

Following a similar approach, National Semiconductor has developed the NS16081 math processor (Fig. 2). In addition to operating as a coprocessor slave in a system using the NS16032 as the main CPU, the support circuit can work as a peripheral in systems using less powerful CPUs.

CPUs also need management

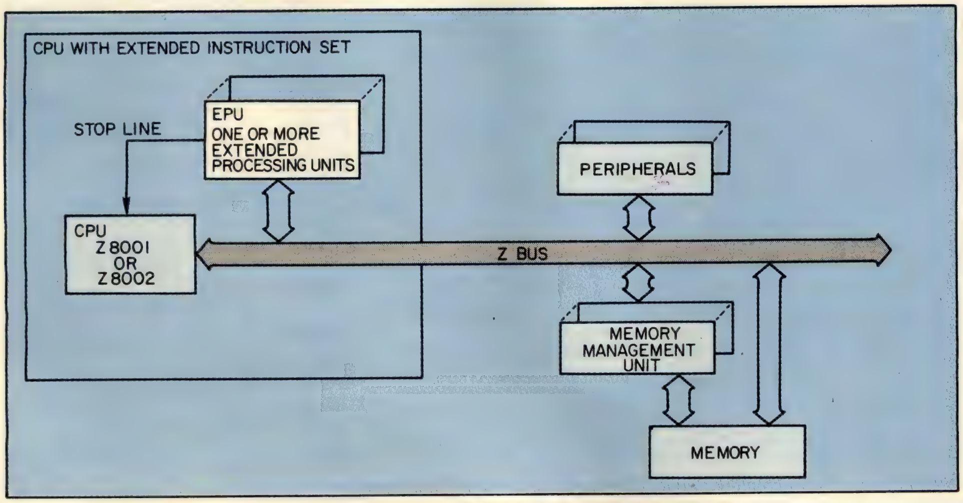
Math support aside, circuits are being developed to manage memory. One of them, Z8010 memory management unit (MMU) just introduced by Zilog, (ELECTRONIC DESIGN, April 26, 1980, p. 128), improves the CPU's ability to handle and manipulate the large amounts of memory available to the programmer (Fig. 3). The Z8010 not only provides such features as read or write protection and logical address space mapping to real address space, it even prevents the user from accidentally trying to execute data.

Connected between the CPU and the memory, the MMU or MMUs divide the memory into sections (segments) that can range from 256 bytes to 64 kbytes long, in 256-byte increments. Pairs of MMUs support the 128 segments possible in the Z8001 address space. Within that space, multiple MMUs can be used to accommodate multiple translation tables or to support even more sophisticated memory management.

At this point, Zilog stands alone with its MMU—but not for long. Motorola is developing its own version, and National Semiconductor has already allotted a part number, NS16082, to a version also still in development that will handle virtual memory. Intel on the other hand, has taken a different approach, and included the basics on the same chip as the 8086 CPU.

Meanwhile, other circuits have been developed to extend the limited memory address range of earlier processors by providing a mapping extension to the processor's limited address range. Such a family has already been introduced by Texas Instruments—the SN54LS/74LS610 series of circuits, which use four address lines in the processor to generate 12 memory-address lines (Fig. 4). This provides a net increase of eight lines, which expands the address space by a factor of 256.

To help it expand the memory, each mapper chip packs substantial amounts of circuitry—a 4-to-16-line decoder, a 16-word by 12-bit



3. Several units extend the processing power of Zilog's Z8000 CPUs by performing such operations as complex math, data-base searches, network interfaces and other functions. Transparent to most system operations, the EPUs work on data in their own registers.

RAM, 16 channels of 2-to-1 line multiplexers, 12 latches and some other circuitry on one chip. The four input address lines are used to select one of 16 mapping registers, each having 12 bits. The contents of the selected register are latched and output to the system, with the remaining lines of the host CPU applied directly to the address bus.

Each mapping register can be loaded with data from the CPU to provide the desired pointer. In addition, the addressable memory available using paging techniques can be increased by periodically reloading the mapper RAM.

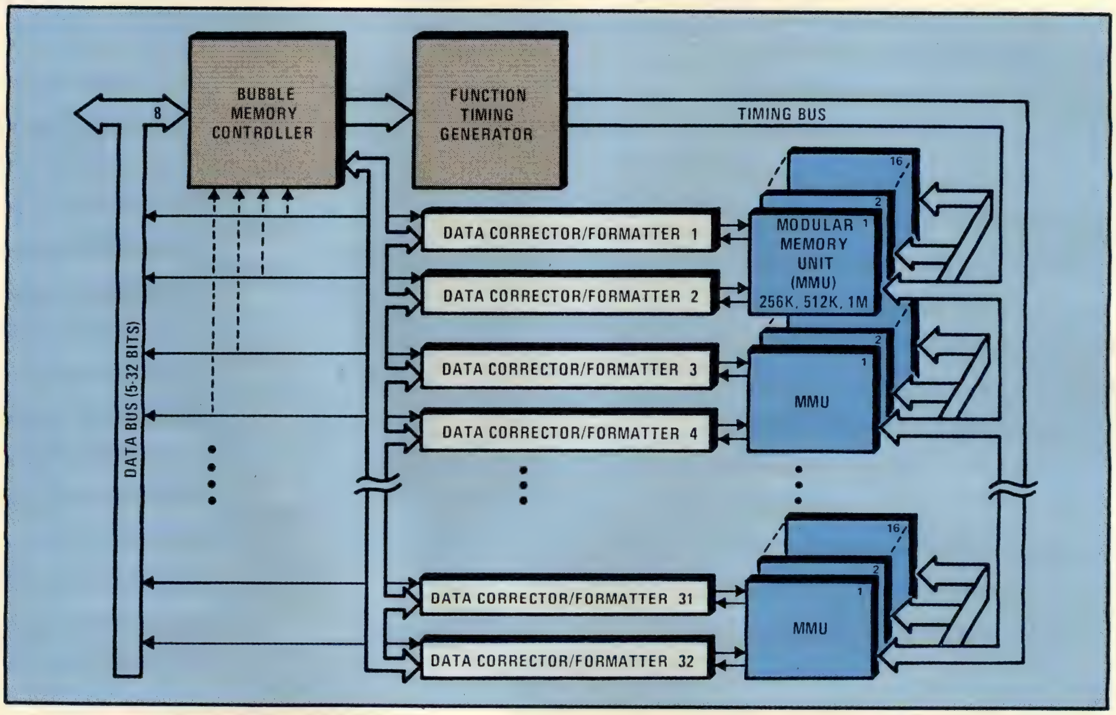
Large systems require refresh control, EDC

Supporting the microprocessor memory from another direction, circuits are emerging to provide dynamic-memory refresh or error detection and correction (EDC). In memory refresh, Intel, Motorola and TI already offer some circuits that help take the headaches out of designing refresh controllers for dynamic RAM systems. However, most of them are suited for 4 and 16-kbit memories and cannot handle the 256-cycle, 64-kbit dynamic RAMs that are just now becoming available for sampling. They could work well, though, with the 128 cycle 64-k's, providing the extra address bit is accounted for.

A recently announced family from Advanced Micro Devices (Sunnyvale, CA) offers complete support for μP and bit-slice systems (AmZ80 and Am29 prefixes, respectively) that use dynamic memories (Fig. 5). Special buffers and interface circuits are included as well as three major LSI components—a memory-refresh controller (the Am2964/AmZ8064), an EDC circuit (the Am2960/AmZ8060) and, just for Z8000-based systems, a circuit that contains all the other "glue" to handle the refresh timing and error logging (the AmZ8063).

The refresh controller can handle either 128 or 256-cycle refresh RAMs, and contains a $\overline{\text{RAS}}$ decoder and $\overline{\text{CAS}}$ buffer to help minimize the time skew between output functions and thus permit a faster memory cycle time. The "glue" circuit for Z8000-based systems accepts control signals to control the RAM timing. In addition, the circuit will interface with the EDC chip and provide a few system extras such as error logging, interrupt on error detection and transparent refresh control.

The Am2964/AmZ8064 chip can perform multiple-


BUBBLE MEMORY CONTROLLER
FUNCTION TIMING GENERATOR
8
TIMING BUS
DATA BUS (5-32 BITS)
DATA CORRECTOR/FORMATTER 1
DATA CORRECTOR/FORMATTER 2
DATA CORRECTOR/FORMATTER 3
DATA CORRECTOR/FORMATTER 4
DATA CORRECTOR/FORMATTER 31
DATA CORRECTOR/FORMATTER 32
16
2
1
MODULAR MEMORY UNIT (MMU) 256K, 512K, 1M
MMU
MMU

4. Support circuits developed by Texas Instruments not only expand a bubble-memory system to 256 Mbits, but also provide the controls for the basic modular memory unit: bus control, function timing, and data correcting and formatting. The unit consists of the bubble device and the direct support (sense amplifier and field-coil drivers).

error detection and single-bit error correction on 16-bit words, and provides the syndrome bits when an error occurs. Housed in a 48-pin package, the EDC can be cascaded so that two circuits can be used for 32-bit-wide data words and four for 64-bit-wide data words.

Expectations are high regarding the EDC's performance: a typical data-in-error detection time of typically 30 ns, and a typical data-in-to-correct-data-out delay of 50 ns. Circuits provided on the chip will provide diagnostic functions that should prove useful during device test and system troubleshoting. The EDC uses a modified Hamming code and requires six additional memory bits for a 16-bit data word, seven bits for a 32-bit word and eight bits for a 64-bit word.

Fixed 16-bit-word EDC circuits developed by TI, the SN54LS/74LS630 and 631, also use a modified Hamming code to provide a 6-bit error code. The circuit flags and corrects single-bit errors, and flags —without correcting—dual-bit errors.

Bubble support eases system design

In addition to circuits that work with dynamic RAM arrays, TI, Intel, National and most of the other companies offering bubble memories have developed specialized control and interface circuits that ease the design of actual interface between a bubble memory and the CPU.

Aside from the simple circuits such as the field-coil drivers and the sense amplifier, bubble-system support typically consists of a circuit that keeps track of the bubble position and controls the flow of data to or from the host system bus. Also part of that interface is a circuit typically used to generate all the timing for the various bubble control and generation pulses. TI, however, has added a third circuit that not only formats and buffers the data but also provides error correction using a proprietary algorithm.

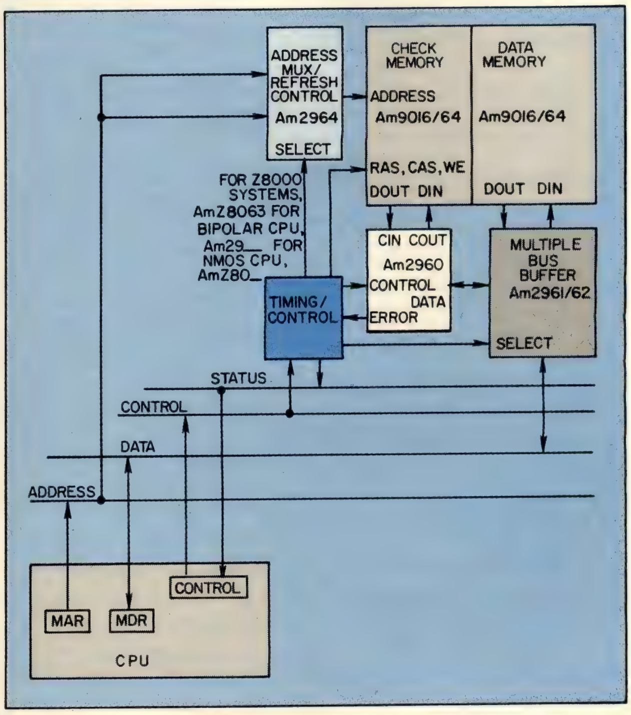
Each company's circuits are dedicated to the company's own family of bubble-memory chips and cannot easily be interchanged, even if the bubble devices have the same number of bits and are organized similarly. All these circuits, though, will permit system expansion to well beyond a single bubble-memory cell. In fact, the TI concept using its family of support components would permit systems with capacities of up to 256 Mbits to be assembled.

The large capacities of the bubble memory systems imply that large blocks of data may be transferred to a host system RAM bank for rapid processing or manipulation. However, since the bubbles are relatively slow for random-access searches (average access typically takes 5 to 15 ms), rapid bulk transfers using DMA techniques are always used.

When is a slave a slave?

"Slave processor" is becoming an increasingly vague term as more and more companies introduce powerful support circuits more tightly coupled to the host processor. National Semiconductor, for example, uses the term "slave" to represent a tightly coupled support circuit that uses some of the CPU's resources to do its job. At the same time, the company has changed its terminology so that the term "peripheral" describes circuits that support the CPU but do not use any of the processor's resources—registers, program counter, etc.

However, other companies are not following National's way. Intel uses the term "coprocessor" to indicate a tightly coupled support circuit, while Zilog uses "extended processing unit." Before the year ends, another company will probably offer yet another term to describe its closely coupled processor support.

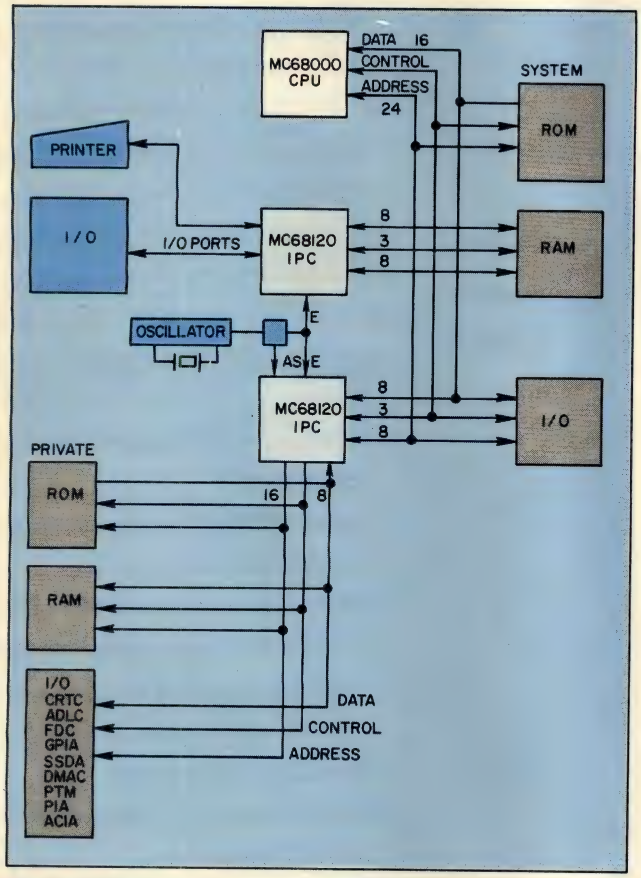


5. The Am29/AmZ80 series of memory supporters from Advanced Micro Devices support this dynamic memory interface to either a microprocessor or bit-slice CPU. Three major circuits are included: an address multiplexer/refresh controller (Am2964/AmZ8064), an error detection and correction circuit (Am2960/AmZ8060) and, for Z8000 systems only, a timing and control circuit (AmZ8063).

Controlling the DMA transfers are more highly specialized circuits, the DMA controllers, which are general-purpose enough to work with bubbles, floppy-disk drives, and any other bulk-storage device. These circuits permit the CPU to effectively remove itself from the data and address buses so that incoming or outgoing data can transfer at rates that can exceed 1 Mbit/s.

DMA slaves gain independence

Basically, the DMA controller operates as a slave to the CPU. Registers in the controller are downloaded by the CPU and when the controller has finished its job, it signals the CPU via an interrupt or control flag. Some of the latest DMA controllers, though, are getting smarter and can almost load themselves from a dedicated memory area or monitor the CPU and provide transfers when the CPU doesn't need either of the system buses (transparent DMA).



6. A single-chip microcomputer from Motorola provides "smart" I/O functions by executing macroinstructions contained in the on-chip ROM. The MC68120 smart controller contains a dual-port RAM that permits data or variables to come in directly from the system bus or from the on-chip CPU or other I/O ports.

Other controllers will provide multiple channels either to permit several different areas of memory to be manipulated at the same time, or to permit several peripherals to rapidly feed or receive data without the CPU having to reload the registers. In addition to interfacing to the peripherals and to a bubble-memory system, these circuits will, as part of the overall control, also have to interface to the system-memory manager. Combining these memory types with such powerful manipulation capability will be just the beginning of systems that seem to think for themselves.

But that's not all yet—not only are the direct CPU support components getting more powerful, but the indirect support (smart parallel I/O, advanced data-link protocol controllers, intelligent CRT controllers, and many other types of support circuits) is bringing even more power to a system.

Smart parallel I/O circuits such as Intel's 8089 and Motorola's MC68120 (Fig. 6) include both programmable I/O and a program storage area. These circuits are actually microcomputers optimized for I/O operations. When mask-programmed, they can respond to a fixed set of macro commands, executing various subroutines that perform predetermined operations—disk control, printer control, bit manipulation, display control, etc.

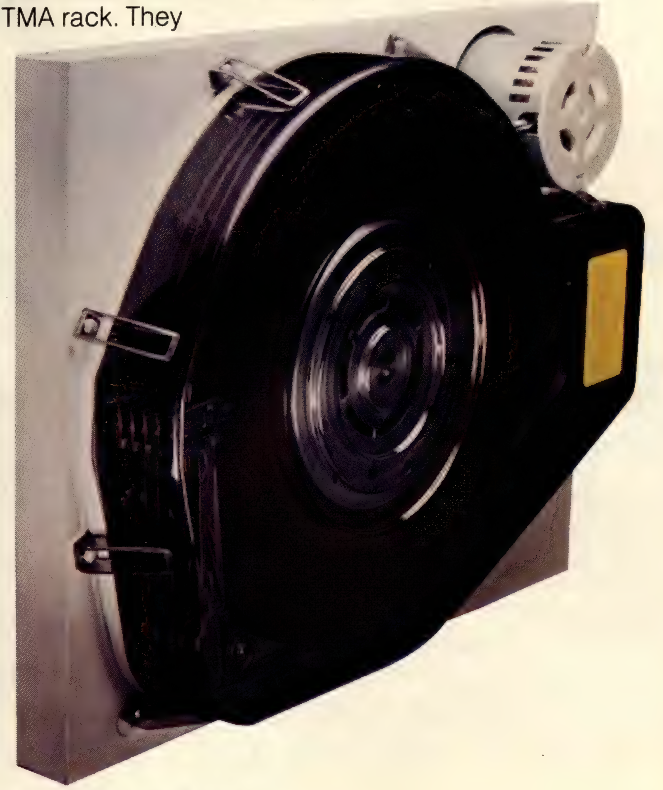
Meanwhile, almost every μP vendor offers at least one CRT controller or graphics circuit to permit the CPU's output to be displayed either on a monitor or on an ordinary TV set. While some of the early controllers permitted the host system to load the basic operating characteristics—line size, number of lines, among other things—the latest generation of controllers will put multiple display windows on the screen with one or more controllable cursors for each window. Other features will include graphics and color-generation capability.

All these improvements geared to distributing intelligence throughout the system are leading up to one thing: true distributed processing for μP-based systems. Many multiple-processor systems already require software to control the network. As designers become better versed in systems, and functions begin to get standardized, the software will eventually appear as hardware built into "smart" support circuits for the 32-bit processor systems expected in the late 1980s.□

Introducing the Shugart SA4100. 58 MBytes for under $3,000.

The affordable solution. The SA4100 is your mass storage solution for all types of multi-function and shared logic systems. Now you can offer your customers a highly cost-effective system with 58 MBytes (or more if you daisy chain) of compact, reliable Winchester data storage. Now you can replace high cost per function storage modules and cartridge drives. And now you can easily upgrade your floppy or SA4000 fixed disk system. Shugart's SA4100. The right drive. The right time. The right price.

Reliable performance with no preventive maintenance. Like our SA4000 fixed disk series, the new SA4100 has Winchester head and media technology for high data reliability. And we've made system integration and upgrading easier, too. For example, SA4000 and SA4100 drives are the same compact size, using only 5.25-inches of panel space and mounting in a 19-inch RETMA rack. They even have the same floppy-like interface. And you can share a power supply with our 8-inch floppy drives. Add to this our proprietary Fasflex II™ band actuator for fast, sure data access with no field adjustment, a sealed media chamber for super data integrity, and a single PCB with all drive electronics for added serviceability and reliability. To help you get started, try our new SA1400 intelligent controller with ECC, resident microdiagnostics, sector interleaving, and buffering. The SA4100. Great features, no preventive maintenance, and super reliability.



The bottom line. Super selection. 14.5, 29, and now, 58 MBytes in our 14-inch fixed disk drive family. All with the lowest cost per Megabyte in their capacity range. All with Shugart's valuable features, quality, reliability, and high volume OEM delivery. And all with the best delivery, technical support, and design assistance in the business. At Shugart, we're Headstrong about giving you more fixed disk value.

Shugart Associates: 475 Oakmead Parkway, Sunnyvale, CA (408) 733-0100. *Sales & Service: Sunnyvale, CA; Costa Mesa, CA; Minneapolis, MN; Richardson, TX; Framingham, MA; Landing, NJ; Atlanta, GA; Toronto, Ontario; Paris, France; Munich, Germany.*

™Trademark of Shugart

Shugart

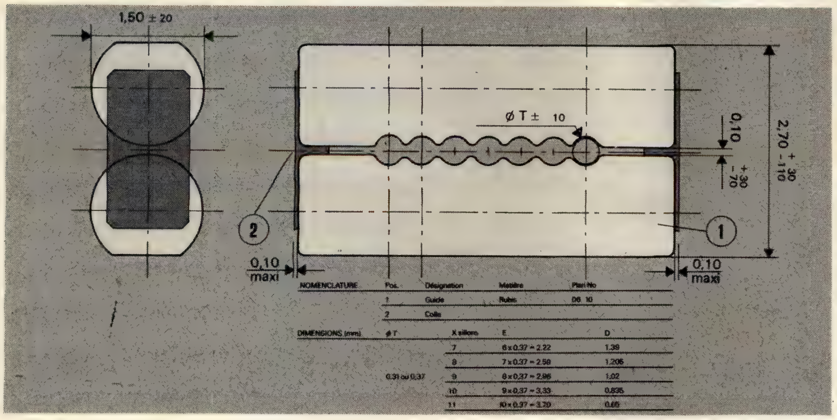
Headstrong about fixed disk value

See us at NCC Booth #2462

CIRCLE NO. 49

New product, lower cost

Seitz, c'est sûr !



NOMENCLATURE	Pos.	Désignation	Matière	Plan No
	1	Guide	Rubis	06 10
	2	Colle		

DIMENSIONS (mm)	ø T	X sillons	E	D
	0.31 ou 0.37	7	6×0.37 = 2.22	1.39
		8	7×0.37 = 2.59	1.206
		9	8×0.37 = 2.96	1.02
		10	9×0.37 = 3.33	0.835
		11	10×0.37 = 3.70	0.65

Wire-guide bars for printing heads

All kinds of material have been tried out for the manufacture of wire-guide bars. The corundum in single crystal structure ($Al^2 O^3$) still remains the best one. Seitz knows it and uses it in an economic and intelligent way.

The form: a cylindrical bar, which means reduction of friction, improvement of the ribbon guiding, elimination of the wear of the head.

Application: in every type of head, thanks to the rigorously respected dimensions and tolerances.

Seitz is the pioneer of wire-guides and is furthermore the most important manufacturer of this product.

Seitz has created and fixed its norms.

Seitz wire-guide bars:
A technical and economic solution.

Design Borel

Seitz SA, CH–2416 Les Brenets, Tél. 039/321112, Télex CH 35505 SEITZ

Pierres Holding, Faubourg du Lac 6, CH–2501 Bienne
Téléphone 032 / 22 65 11, Télex 34 566

CIRCLE NO. 50

...While development tools support multiple users

An 8-bit approach to development problems slowly collapses in a 16-bit world; software management, storage capacity, emulation capability and language level must reflect a change in performance that is greater than the literal 8 bits involved. For the newest 16-bit microprocessors, development system support encompasses:

- Entirely new software-development schemes, involving multiple users
- Faster CPUs and high-speed disk storage to support larger programs
- Low-cost in-circuit emulation, a growing necessity for μP development
- High-level languages, from both system makers and independent vendors
- Comprehensive hardware and software support that works for all μPs.

Most 16-bit microprocessors perform as much as an order-of-magnitude better than the microprocessors in most development systems, and boast a concommitant increase in addressing capability. The technical problem of executing in memory locations that are beyond the addressing range of the 8-bit processor can be circumvented by developing appropriate programs. But a system that comprises 200 kbytes of code creates a software management problem.

The task must be broken into software modules, each developed by a different programmer, and the programmers must share the development system. While one programmer wants to input and edit a module, another programmer has his module ready for hardware/software debug.

One solution, from Intel, is a recent addition to the company's Intellec Series 2 (Fig. 1). Through the addition, the development system communicates directly with either a VAX minicomputer or an IBM 370 mainframe, and the responsibility for program management chores is transferred to the mini or mainframe. The development system is completely freed from program management.

The addition also unloads the development system from the time-consuming management of programs that are entered and edited by many programmers working on one project. Instead, the development system merely compiles code which a programmer enters via a terminal on the mainframe or mini. It then debugs the hardware/software integration through in-circuit emulation. The programs create source-code files at terminals on the mainframe or mini, which are stored on disk. Later, the files are downloaded from the development system, where they are compiled and returned to the larger system for disk storage.

Downloading, from mainframes and minis to an evaluation board, has long been necessary for Motorola's 16-bit 68000. The company's latest development system, EXORmacs, takes over program development but retains the ability to download. Two RS-232C serial ports handle the unloading. One port connects to the user CRT terminal and the other to a time-shared system. Programs developed on the time-shared system are transferred to the microprocessor development system by an EXORmac command. Time-sharing is one alternative to downloading that may have more value for the long term. Many companies offer development systems with

1. Intel's Intellec Series 2 supports all of the company's microprocessor products, including its latest 16-bit processor, the 8086. Intel recently upgraded the system by changing the central processor from the 8080 to the 8085 and by adding a removable cartridge disk drive.

Jonah McLeod, Instruments Editor

network capability.

Hewlett-Packard's implementation is typical (Fig. 2). Up to five development stations can share the major system peripherals—a hard-disk drive with several megabytes of storage and a high-speed line printer for program listing. Costly individual peripherals for each development station are not necessary; as many as five programmers can develop code simultaneously with the same data base; and program-management is easier precisely because the data base is shared.

Four other systems similar to the HP are the Universal Microprocessor Development System from Boston Systems office, the MUDS-11 Internal Data Services, the Microflame system from Fairchild and the "Software Synthesizer" from Scientific Enterprises. All are based on minis rather than micros: DEC minis drive the first two, Fairchild's Focus XVI mini drives the third, and a Perkin-Elmer Series Sixteen mini drives the fourth. Each supports simultaneous development, by four or eight users.

The GenRad Futuredata 2300 Series Advanced Development System Network (Fig. 3) comes with up to eight development stations, each working in a different μP language. Each station can have its own slave emulators for independent debugging of software/hardware integration. A network control processor ties together all of this capability. It oversees access to the system's shared resources: a line printer and one of the first implementations of an 8-in. Winchester disk drive. Although the intent of the system is to share costly peripherals among several users, the structure also accommodates multiple programs for the same microprocessor.

Undoubtedly, other makers of microprocessor development systems will follow the trend toward products with multiuser capability. In the fourth phase of its EXORmacs system, Motorola will add an intelligent serial communications controller, an intelligent hard-disk controller, up to 1 Mbyte of memory and a multiuser operating system. These elements permit a wide range of system configurations, from a multiuser software-development system to a multichassis hardware and software system. As in the Futuredata system, the remote chassis can suport several parallel development efforts or independent development of many different microprocessors.

New generation of Winchesters

Pressed by ever-larger programs and by the demands of multiple users, storage space and storage access time are becoming critical problems. Any hard-disk drive can supply the storage space and the access time, but at what cost and with what level of reliability? Less expensive cartridge disks in particular are not entirely reliable in the computer-room environment. Enter the new generation of 8-in. Winchesters, priced like a removable cartridge drive but far more reliable.

2. The HP64000 is a multiuser system with a high-performance 16-bit processor and Winchester disk drive. It supports program development for the 6800/6809, 8048/8021, 9900, 1802 and F8/3870.

At least two manufacturers of universal microprocessor development systems and several builders of dedicated systems have begun upgrading to the latest μPs or announced an intention to do so. One or two of these systems incorporate the latest 8-in. Winchester drives, through the foresight of the development system's maker or through the enterprise of third-party vendors.

To a user, all of this new technology translates into better performance, lower cost and better reliability. Certainly, compilation for a 16-bit systems will be faster on the latest 16-bit processors.

Rather than augmenting the powers of 8-bit μPs, the suppliers of microprocessor development systems look to 16-bit μPs. These 16-bit μPs (Fig. 4) are available from Motorola (the 68000 in its EXORmacs system) and Texas Instruments (the 9900 in its AMPL 990 development systems). National will build a completely new hard-disk-based development system based on the NSC16000 16-bit processor.

The system will support multiple users and distributed program development. Eventually, similar 16-bit μPs can be expected from all semiconductor manufacturers.

One dedicated development systems maker, Advanced Micro Computers has opted for a different approach to incorporating a 16-bit product. The company's AmSYS 8/8 System currently uses an 8-bit processor, but the system is based on a single-board computer. As new boards come along—like the AmZ8002-based 96/4116 board—they can be dropped into the development system. Moreover, a board with the AmZ8001 CPU will soon offer full 8-Mbyte memory addressing. Beside adding top-performing CPUs to their system, AMC will be offering a hard disk.

Fairchild is yet another semiconductor manufacturer with a 16-bit-based system. Its Microflame system is designed around the company's Focus SVI minicomputer. However, its older technology, either 10-Mby to 300-Mbyte storage modules. Intel has not aggressively pursed the latest technology in its microprocessor development systems—an 8080 drives system and a cartridge disk serves for mass storage—but its strategy may be changing. Recently, the company announced the retirement of the 8080 as the development system's main CPU, in favor of a 8085. Later this year, the company plans another product introduction, the Intellec Series 3, high-performance system.

Among the universal development system suppliers, the most prominent example of 16-bit technology can be found in the Hewlett-Packard HP64100A System, a mini of HP's own design. HP has recently announced an 8-in. Winchester to complement its current 14-in. hard-disk drive. Hard-disk storage appears in development systems from the Boston Systems Office (a DEC Mini) and Scientific Enterprises (a Perkin-Elmer mini). The former uses 5-Mbyte removable cartridge; the latter uses a 38-Mbyte Winchester. GenRad Futuredata, too, has begun to design-in the new crop of 16-bit processors; its 8086 Slave Emulator Control Unit is based on an 8086 CPU. The company also offers the latest 8-in. Winchester disks.

Everybody loves an emulator

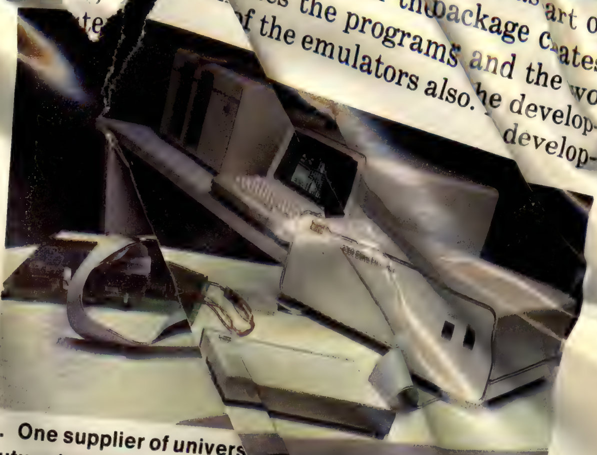
Outside the development system proper, creative activity is most intense around the in-circuit emulator. One trend is toward multiple in-circuit emulation to support systems with more than one microprocessor.

Multiple-ICE capability is essential in debugging problems and attributing blame in multiprocessor systems. Problems arise when several microprocessors sharing a common memory run asynchronously. If one processor should overwrite constants stored by another, a fault results. Likewise, trouble arises when interrupts from one processor to another occur too close together.

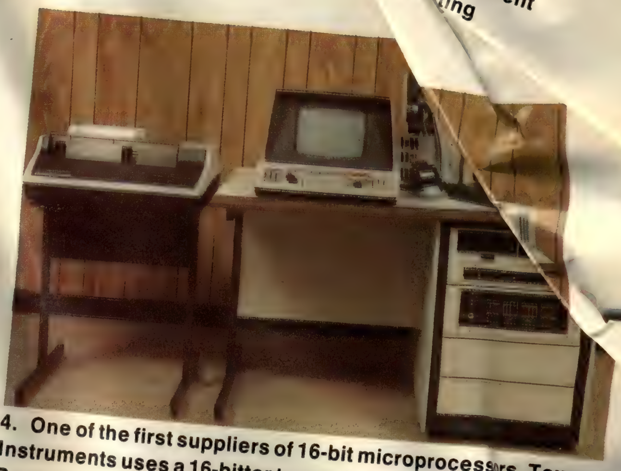
Suppliers have approached this problem in two ways. One method leans on individual stand-alone ICE modules for each processor in a system. Each module emulates its processor without regard for the others, and reports its condition to the host development system.

The stand-alone module meth ... three advantages: First, the emulator ca ... erate independently of the development syst ... programs can be developed and emulated simultaneously. Second, more than two emulators can operate concurrently within the same system. Third, the user can select emulators other than those supplied by the development-system maker. The ... method is that it f ... back of the software that permits co ... micro devel fragme ... the stand-alone emulators, so ... development ... develop- if related programs are ... merg ... ted tra ... no time ... ion. Thus, ... the micro de ... ult to ... a limited ability to detect interact ... erly in rea multiprocessor ... ent system

In the second approach ... into the development system emulators ... blems in a system. A multi-ICE soft ... operate as ... rectly em ... ware interface between the package ... art of me ... tors; it ... executes the programs and the ... creates ... te ... of the emulators also. ... develop- ... two ... develop-



3. One supplier of univers ... Futuredata, offers the 2300 ... lopment systems, GenRad System Network, with up to ei ... dvan ... Development programs and debugging hardw ... ons fo ... ting



4. One of the first suppliers of 16-bit microprocessors, Texas Instruments uses a 16-bitter to power its AMPL 990 Development System.

ment system can record a coordinated set of trace information, an advantage over the multiple stand-alone method. An interactive command language permits the programmer to control the operation of both emulators and of the development system by means of a keyboard entry or a command file on a diskette.

w suppliers now offer the
fe roach, so very few processors
Unfort ulator app one supplier with the 8085 and 8041
ported. Intel is 8085's and the Starplex system (Fig. 5) can
8085 and 8049, tw simu ltaneously. However, it
combination. Natio ple of pr ocessor combinations.
handle two proc offer stand-a emulators mod-
supports only operate in a pplie tiple-emulator c and
Most su However, twovision rs—GenRad 02
ules th for this ca , full-
figu tion. make hardw ne GenRad s ystem micro-
Phi ps— A recent additi trol Unit, permits or/memo-
tr. Slave Emulator with multiple 8 or ces eous oper-
speed emula separate memory and multan or and up
processors permit independent and processor product
ry buses of the development-sys t the Philips (DESIGN,
ation to eight emulators. At pre (see ELECTRONIC around a
is available only in Europ The system is built simultaneously
Oct. 11, 1979, p. 21). CPU which can sim ith different
16-bit mini/micro microprocessors
emulate up to fou emulation is a
architectures. multi architecture. The
With other suppliers, allows six work
byproduct of development-sy tly. Each can develop
HP64000 from Hewlett- work station can be
stations to operate inde processor of a multiple-
programs or emula back is the lack of coordi-
configured to em various emulators. However,
processor syste the control function between
rotations.
nated city is available on development
the vari stand-alone emulators that com-
Similar
system

5. National Starplex will soon expand its development system to offer Pascal, PL/M and in-circuit emulation for the company's NSC-800 and NSC-16000 microprocessors.

municate with the host's microprocessor development system via an RS-232C serial interface. Systems that fall into this category include the E-H International MicroSupport System and Advanced Micro Computers (AMC) AmSys8/8. The former has four serial I/O ports. The ports can connect three stand-alone emulators currently offered by the company (for the 8080, 8085 or Z80A microprocessors). On the AMC system, I/O ports can each interface 8021, 8041, 8048, 8049.

Emulators that stand alone

Independent vendors (mostly, those who do not offer development systems) are currently offering stand-alone in-circuit emulators for use with the common microprocessors. These products fall into two categories: those that can tie back to a development system and those that are truly stand-alone. Both offer some benefits that make them a viable alternate or supplement to products supplied by development system builders.

Foremost of the user benefits is that the emulator does not tie up the development system. Debugging occurs on the emulator. The emulator serves, not only as a design aid, but also as a troubleshooting tool once the product is in the field.

But what adds the most versatility to this category of emulator is an RS-232C link which gives the user the option of tying back to his development system. Therefore, the emulator can be connected into and used with any development system. Perhaps more significant, emulation can be added to any system with an RS-232C from a mainframe or minicomputer down to a dedicated development system. Mainframes and minicomputers get a hardware debug ability that was not commercially available before. Development systems get emulator support that may not have been available (for instance, a Z80 emulator for an Intel MDS) or a novel connection between a MOS-processor emulator (like the AmSYS 8/8800) and a bit-slice development system (like the SYS 29 from AMD, (Fig. 6). For troubleshooting in the field, the emulator can be linked from a remote site to a central repair facility via a modem.

Still another benefit is a longer range for breakpoints. In the past, many in-circuit emulators could break only to an address. The limitation made it nearly impossible to detect an erroneous program jump into a sensitive section of memory containing, say, constants, symbol tables or operating-code system code. The software problem that causes an unpredictable jump is difficult to find without the breakpoint. With the new capability, an operator need only specify a breakpoint for a range of addresses (say 1000_{16} to 9000_{16}). A breakpoint would occur any time the CPU attempted to execute a jump

RAMming through microcode for bit-slice systems

The writable control store (WCS) is a RAM memory that holds microcode under development for bit-slice systems. Unless the RAM is fast enough, the designer has to debug the microcode at less than real-time speeds and then burn the program into PROM to test at normal clock rates. The pressure for speed in the WCS is also exerted by other aspects of microcomputer development systems: faster PROMs, larger memory capacities for larger programs, computers and controllers built with bit-slices, high-performance Winchester disk drives and faster signal processing systems.

Among the suppliers of high-speed WCS, Step Engineering has introduced an enhancement to its Step 11 Bit-Slice Development System—a 32 × 1-k WCS with 36-ns access (the MEM-23F). Another WCS, the MEM-128F, is 32 × 4-k and offers 50-ns access. Behind both improvements is the latest high-speed static RAM.

AMC offers the System 29 Advanced Microprogram Development System; it is a microcomputer-based (AM 9080) system—unlike the Step system, which requires a minicomputer or mainframe. When code is developed on a mini or mainframe, it must be downloaded into the bit-slice system for real-time debug.

Operating much like the Step system, the MACE29/800 Microcode Analyzer and Control Storage Emulator from Motorola debugs microcode after it is prepared by the Motorola EXORciser Development System. The code is then downloaded into the MACE unit. The Step and Motorola systems both sport a real-time trace capability—a powerful tool for selectively examining troublesome portions of the code during real-time operation. It speeds up the debug process considerably.

to an address within the specified region.

Some stand-alone in-circuit emulators provide a real-time trace. The designer takes a selective snapshot of his system while it runs at full speed. During operation of the emulator, trigger events (such as a program address or the detection of a status word in the target system) start a trace of the system bus. In addition, a pass counter and delay counter further specify when to trigger the trace, after n occurrences or after n counts from the first occurrence. Once the trigger condition is satisfied, the bus history of address and data are stored in the emulator memory for the designer to examine. In function, the feature resembles the state-captive capability of many logic analyzers.

Stand-alone in-circuit emulators, with both RS-232C interface and real-time trace, were pioneered by Millennium Systems and are available on the Series 1000 and MicroSystem Analyzer 2000 and 4000 (Fig. 7). Relative newcomers also offer all three features—E-H International on its Micro-Support In-Circuit Emulators, Applied Microsytems on its EM-186 and EM-188, and General Instrument on its PICES unit. E-H and Applied Microsystems support the 8080, 8085, and Z80. Millennium supports these processors plug the 8048, 8049, 8041, 8035, 8039, 8748, 8021, 6800 and 6802. The PICES unit exclusively emulates General Instrument's 1650 microprocessor.

In-circuit emulators that tie directly into the development systems of specific suppliers come from Relational Memory Systems, Inc. (Los Altos, CA), which offers Z80 emulators for the Intel development systems.

A separate microprocessor system analyzer can be clipped onto the µP to monitor the µP's operation. Like the emulator, the analyzer provides a control panel; but unlike the emulator, it does not supplant the target-system microprocessor. AQ Systems Inc. and Pro-Log supply analyzers for the 8080, 8085 and Z80 microprocessors.

For debugging a program prior to its integration into the hardware, the simulator provides a major benefit not offered by in-circuit emulation. It lets several programmers simulate software simultaneously. One new simulator that offers this all-together programming capability is the SI/MICRO-11 from Boston Systems Office (ELECTRONIC DESIGN, April 12, 1980, p. 30).

Another simulator which works outside a purely digital world is offered by Intel Corp. for its 2920 analog signal-processor chip (ELECTRONIC DESIGN, Dec. 6, 1979, p. 106). The SM2920 permits debugging that would not be possible if the software executed in the signal processor itself.

Channel Command

System	Standard system components	CPUs supported	Support software	Support hardware
Advanced Microcomputer AmSYS 8/8 (Sunnyvale, CA)	AM9080A CPU, 32-k RAM (64-k optional) dual 8-in. floppy drives, CRT & keyboard, printer, tape punch, reader, RS-232C serial port or current loop, parallel I/O ports	Z80, 8080, 8085, Z8000	Editor, macro-assembler (all CPUs), 8080/Z8000 translator link & loader; Pascal (all CPUs), Basic, Fortran, Cobol (8-bit processor)	Z8000 prototyping board with in-circuit emulation (ICE) capability
American Microsystems Inc. MDC-100 (Santa Clara, CA)	6800 CPU, 16-k RAM, dual 8-in. floppy drives, CRT & keyboard, printer, RS-232C serial & parallel I/O ports	S2000, 6800	Editor, macro-assembler, link & loader; Basic, Pascal	DEV-2000 emulator, 6800 prototyping boards, EPROM programmer, MDC-140 logic analyzer
Applied Microsystems Corp. EM-186 EM-188 stand-alone emulators (Kirkland, WA)	32 × 250 trace memory, RS-232C serial I/O port, optional 8-k RAM, Scope trigger loop	Z80, 8080 8085, 6800 6802, 6808 68A00, 68B00	Monitor software	Attaches to external terminal, MDS system or mini
Boston Systems office UMDS-40 Universal Development (Waltham, MA)	16-bit DEC mini, 128-k RAM, dual-floppy drive, cartridge-disk drive, 8-line RS-232C multiplexer, hardcopy or CRT, printer programmer console	8080 family; 4004, 4040; 8048 family; 8086; 6800 family (6809, 68000); Rockwell PPS family; National IMP PACE, SC/MP; TMS9900 family; 1802, 1804, 6502, Z8, Z80, Z8000, 5200	Editor macro-assembler (all CPUs); simulator debugger; Pascal, Fortran	Stand-alone emulators from third-party vendors or other manufacturer
Cybersystems Inc. DACS5100 DACS 5300 (Huntsville, AL)	μC-based system, 32 to 56-k RAM, CRT, keyboard, dual-floppy drives, double-sided double-density printer	6502, 6802 6809, Z80 8085	Assembler, editor Basic, debug utilities	PROM programmer
EH Intern'l Micro Support Development System (Oakland, CA)	16-bit mini 32-k RAM (64-k optional), 10-Mbyte Winchester disk, 4 serial I/O ports, floppy disk, CRT & keyboard, printer optional	8080, 8085 Z80A, 6800 6802	Editor, macro-assembler (all CPUs), Pascal system, Boston Systems Office software	8080, 8085 & Z80A emulators, PROM programmers
General Instr. PICES In-Circuit Emulation System (Hicksville, NY)	CP1600 μC RS-232C serial I/O port, or current loop	General Instr. 8-bit PIC family of μPs	PIC cross-assembler for use in external mini of MDS system	Attaches to external terminal, development system or mini
GenRad Futuredata Advanced Development System (Los Angeles, CA)	CPU (selectable), 48-k RAM, CRT & keyboard, dual double-density floppy drives, printer	8080 family; 8086; Z80; 6800 family; (6809, 68000); 1802; 3870 family; 8048 family; Z8000	Editor, assembler, linker, debugger, cross-assemblers; Basic (compiler & interpreter versions), Pascal	Emulators, logic analyzer, PROM programmer

System	Standard system components	CPUs supported	Support software	Support hardware
Hewlett-Packard HP64000 Microcomputer Development System (Palo Alto, CA)	16-bit mini, 64-k RAM, CRT keyboard, 12-Mbyte Winchester disk or fixed cartridge drive (9.8 to 120-Mbyte), RS232-C serial I/O port options (printer and cartridge tape)	Z80, 8080 8085, 6800, 6805/6809, 8048/8021, 9900, 1802 F8/3870	Editors, macro-assemblers (all CPUs), linking loader & debugger	Emulators for Z80, 8080, 8085, 6800
Hughes Semiconductor Products HMDS 2D (Newport Beach, CA)	Z80 CPU, 16-k RAM (expandable) dual double-density 8-in. floppy drives, CRT & keyboard, printer, RS-232C serial & parallel I/O ports	1802, Z80, 8080, 8085	Editor, assembler, monitor/debugger, Basic compiler (for 1802)	ICE capability for all CPUs, PROM programmer, light pen
Intel Corp. Intellec Series 2 Model 240 (Santa Clara, CA)	8085A-2 CPU, 64-k RAM, CRT & keyboard, 5440-type hard disk, single 8-in. floppy-disk drive, RS-232C serial & parallel I/O ports, printer, tape reader/punch	8080 family, 8048 family, 8086	Editor, macro-assembler (all CPUs), 8080/8086 translator, link & locate; PL/M-86 ASM-86; Basic, Fortran, Cobol (all 8-bit processors)	ICE (all CPUs) except 8088), multi-ICE (two CPUs emulated simultaneously), PROM programmer
Millennium Systems Inc. MicroSystem Designer-Series 1000 & Emulator-Series 2000 (Cupertino, CA)	Peripheral-control processor, 1-k RAM, cassette interface, alphanumeric display, hexadecimal keyboard, serial I/O ports	Z80, 8088, 8086, Z8000, 6800, 6802, 8048, 8085 (soon support for all 8048 family)	Monitor software for program development, debug system control; system allows up/down load to host computer system for major program development	μP personality modules
Mostek Corp. Matrix Development System (Carrollton, TX)	Z80 CPU, 32-k RAM, dual floppy-disk drive, RS-232C serial & parallel I/O ports	Z80; can be set for 3870 CPU	Editor, macro-assembler, linking loader, debugger; Fortran, Basic, PL/1S, Cobol	PROM programmer & ICE capability
Motorola Semiconductor Products, Inc. EXORciser II EXORmac, and EXORset (Phoenix, AZ)	6800 CPU, 64-k RAM, debug module, RS-232C serial & parallel I/O ports, EXORterm 200/220 CRT & keyboard; EXORdisk II dual floppy-disk drives & printer optional	6800 family & 68000 (all CPUs of company supported, including 6809)	Macroassembler, editor, linking loader, Cobol, Basic, Fortran, MPL (all CPUs except 6809 and 68000 which have macroassembler), Pascal	PROM programmer 68000 prototyping board with emulation capability, ICE (all CPUs, including 6809); system analyzer (for added hardware debug)
National Semiconductor Starplex (Santa Clara, CA)	8080 CPU, 64-k RAM, CRT & keyboard, printer, dual floppy-disk drive, RS-232C serial & parallel I/O ports	8080, 8085, 8048, 8049, Z80	Editor, macro-assembler, debugger, linker, loader, Basic, Fortran	PROM programmer, ICE (all CPUs)
Rockwell International System 65 (Anaheim, CA)	6502 CPU, up to 64-k RAM, dual mini floppy-disk drive, CRT, & keyboard, printer, RS-232C serial & parallel I/O ports	6500 and 6500/1 single-chip computer	Editor, assembler symbolic debug monitor; PL/65, Basic	ICE (for 6500) & personality option (for 6500/1); PROM programmer
Solid State Scientific μMOS Development System (Montgomeryville, PA)	SCP1802 CPU, 16-k RAM, dual 8-in. floppy drives, CRT & keyboard, printer, RS-232C serial I/O port	1802	Editor and macro-assembler μFORTH	ICE capability, EPROM programmer

(continued on page 148)

System	Standard system components	CPUs supported	Support software	Support hardware
Signetics Twin (Sunnyvale, CA)	μC based, CRT, keyboard, up to 64-k RAM, dual floppy disks RS-232 interface and current loop	2650	Assembler, editor, debug software	PROM programmer hardware debug via test ware; ICE
Step Engr. Step 2 Firmware Integration Test Station (Sunnyvale, CA)	μC-based, writeable control store, 32-k × 768-k × 8 (to 192)-bits	All bit-slices & 8 × 300, 29116; 8X02 ROM-based logic; simulates all bipolar PROMs, EPROMs	Transportable meta-assembler (all 16-bit minis and larger, offering Fortran post-processor for PROM programmer	Peripherals & PROM programming available from independent vendors
Synertek Systems MDT1000 (Sunnyvale, CA)	6502 μC, CRT, keyboard, 4 to 16 k of RAM dual cassette interface, serial RS-232 interface, parallel printers interface	6502	Assembler, editor loader, optional Basic	Peripherals & PROM programming from independent vendors
Tektronix 8002A Microprocessor Development Lab (Beaverton, OR)	User-selected CPU, 80-k RAM, floppy-disk drives, RS-232C serial I/O ports, CRT & keyboard, printer	8080/85, 6800, Z80, TMS9900, 3870/72 1802, 8048 family	Editor, macro-assembler, linker, debugger, Basic and Fortran for 8080, 8085, and Z80	ICE capability, real-time trace capability, PROM programmer
Texas Instruments FS 990-AMPL Microprocessor Prototyping Laboratory (Houston, TX)	FS990 CPU, 24-k RAM, CRT & keyboard, printer, dual 8-in. floppy-disk drives	All 9900-family CPUs	AMPL (language) Pascal, Fortran, Basic	ICE (all CPUs, logic-state trace, PROM programmer)
Video Specialties Target Computer System (Solano, CA)	μC based, 500-bytes RAM, alphanumeric display, hex keypad, printer port, cassette I/O port, RS-232 serial I/O port	2650	Monitor program	PROM programmer for 2716, 2758, or 2516 EPROMs, printer, cassette EPROM eraser, available captions
Xycom 3805A Host Development System (Saline, MI)	Z80, CPU, up to 96-k RAM, standard single floppy (dual floppy optional CRT, keyboard, printer, four serial ports, for 20-mA, RS-232C, RS0424A or RS-423A configurations)	Xycom μC boards	Editor, assembler, industrial Pascal, printer, loader, Basic, Fortran	EPROM programmer
Zilog PDS 8000 (Cupertino, CA)	Z-80 CPU, 60-k RAM, CRT, keyboard, serial RS-232 I/O port, dual-floppy drives, 10-byte hard disk, optional printer	Z8, Z80, Z8000	PLZ/ASM, Z8000 translator Pascal, Fortran, Cobol, editor, macroassembler, pulser, loader	Z8000 development module, PROM/EPROM programmer, ICE capability, logic-analyzer capability

The growth-spurt in program development calls for high-level languages that can free the designer from concern with the details of microprocessor operation and let him concentrate on design problems. In recent months, attention has focused on enhanced versions of Pascal and on PL/M and its derivatives. Other high-level languages with a following (most notably Basic Fortran and FORTH) have also received additions and enhancements.

With 8-bit microprocessors, programs written in high-level languages consume more memory than programs written in assembly language or in binary machine code. To get around the problem, suppliers offer languages for 8-bit execution that use less memory by producing a more efficient object code. Languages like PL/M from Intel, PL/Z from Zilog

INTRODUCING

THE MILITARY KEYBOARD

"FULLY ARMED"

BEEFOOPERFLOP!

That's about all anybody will get when they try and listen in on a message or command being transmitted by a Key Tronic Military keyboard.

Key Tronic Corporation has been supplying the industrial and Military "Hi-Rel" markets for over ten years.

Key Tronic's hermetically sealed Reed-Switch is the answer to any rugged military assignment.

Write and ask us for more information about our "Fail-Safe Plan", "Spy Proofing", "Targets" and "Service Record."

Key Tronic knows how to keep a secret.

key tronic
INTERNATIONAL KEYBOARDS

P.O. BOX 14687 — SPOKANE, WASHINGTON 99214 U.S.A. PHONE (509) 928-8000 — TWX 510 773-1885

CIRCLE NO. 51

and Pascal—first formulated for microprocessors by Texas Instruments—make concessions to the microprocessor environment. They permit concurrent processes, have input/output capability, handle interrupts and offer other features, yet produce a minimum of object code.

The other features include calls to assembly language programs and access and control of status and other working registers in the microprocessor. These powerful extensions put minute microprocessor operations under the control of the high-level language, minimizing the need for assembly language.

Other improvements now under way involve making the language machine-independent. Conceivably, a designer could write a PL/M program that runs on a 6800 as easily as on an 8086. Two companies currently produce compilers for developing such programs. Language Resources (Sunnyvale, CA) offers the Language Resources Pascal System; and System Consultants Inc. (San Diego, CA) offers PLMX, which the company claims can be used with any 8 or 16-bit microprocessor, currently available or yet to come.

Both products are true compilers in that they produce native binary code. Though binary code is inherent in PL/M, for the most part it is not inherent with Pascal. Pascal usually produces a P-code that must be interpreted by the target microprocessor. *Basic* is another language that needs an interpreter.

When a resident interpreter is necessary, memory requirements are larger and execution is slower since each instruction has to be interpreted. Some memory development systems use 10 kbytes of memory for the interpreter alone.

Now, however, both Basic and Pascal are moving away from interpreters toward compilers. The efficient compiler directly produces native object code that is executable on the target microprocessor. Such high-level language compilers come from Texas Instruments, Motorola and Boston Systems Office. Basic compilers are offered by GenRad Futuredata, Motorola, Hughes Semiconductor Products and Tektronix.

Many companies now have a derivative of PL/M or soon will. Intel Corp., the creator of PL/M, is joined by Rockwell with a version called PL/65, by Motorola with MPL, by Zilog with PL/Z, and by Mostek, which has plans for a PL/1S version.

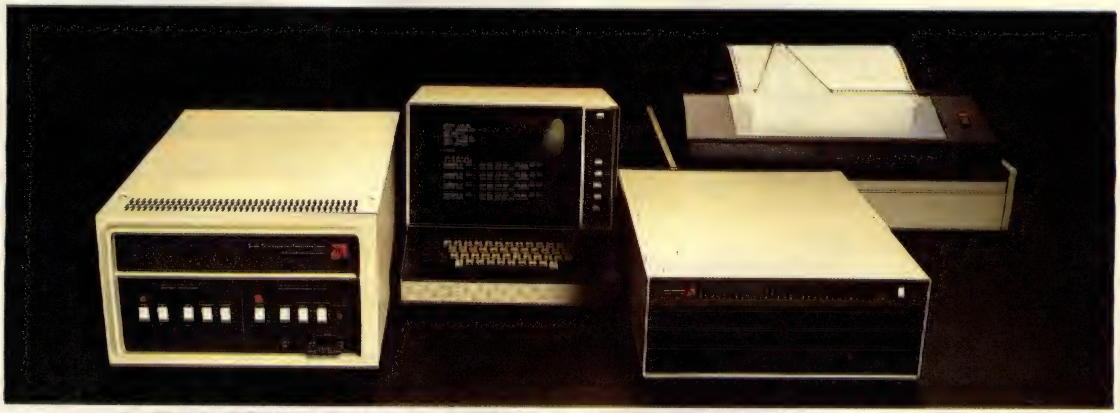
Two other languages—FORTH and Fortran—have begun to appear in most microprocessor development systems. The former serves for microprocessor-system program development; the latter is a development tool for writing applications programs like statistical analysis routines. In addition, with Fortran, a development system can undertake general-purpose data processing when it is not involved in program development.

FORTH offers many of the benefits of PL/M and Pascal, and requires very little memory; hence it is an attractive language for developing programs to run on smaller 8-bit microprocessors, like the 1802. Companies offering FORTH for microprocessor development include Solid State Scientific Inc. (Montgomeryville, PA) and Diversified Technology (Ridgeland, MS), both for the 1802.

Assemblers are getting savvy

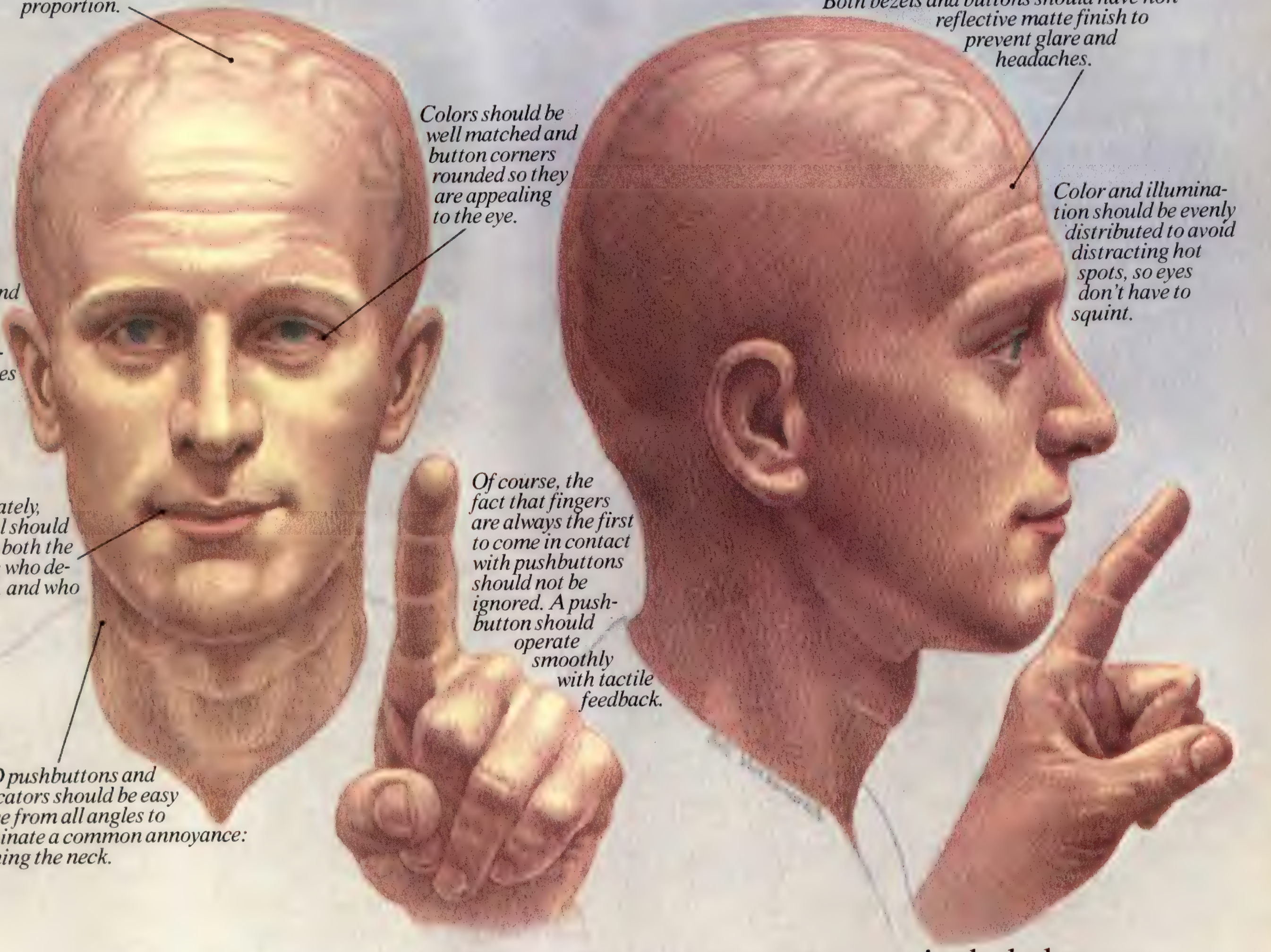
High-level language is an important tool for software development, but the assembler is still indispensible. Assemblers are evolving. They are now relocatable via software, and they have macro facilities, which enable a programmer to create macroinstructions that can be called like any other assembly-language instruction.

Assemblers are gaining the ability to handle pseudo operation codes or assembler directives and learning high-level languages. Along with faster assembly time, these features add structure to as-



6. With its RS-232 serial interface, the SYS 29 Microprocessor Development System from Advanced Micro Computers easily ties into a stand-alone emulator, like the AMYS 8/8800. The SYS 29 is a bit-slice development system.

A pushbutton panel should be designed for parts of the body besides fingers.



A panel should appeal to the mind's sense of proportion.

Both bezels and buttons should have non-reflective matte finish to prevent glare and headaches.

Colors should be well matched and button corners rounded so they are appealing to the eye.

Color and illumination should be evenly distributed to avoid distracting hot spots, so eyes don't have to squint.

Audible feedback should correspond to tactile feedback when finger pushes button.

Ultimately, a panel should please both the people who design it, and who use it.

Of course, the fact that fingers are always the first to come in contact with pushbuttons should not be ignored. A pushbutton should operate smoothly with tactile feedback.

LED pushbuttons and indicators should be easy to see from all angles to eliminate a common annoyance: craning the neck.

When we designed the Advanced Manual Line (AML), we included everything a designer could want.

Like a broad selection of pushbuttons, indicators, paddles and rockers. In a variety of shapes, sizes and colors. With LED, incandescent or neon illumination.

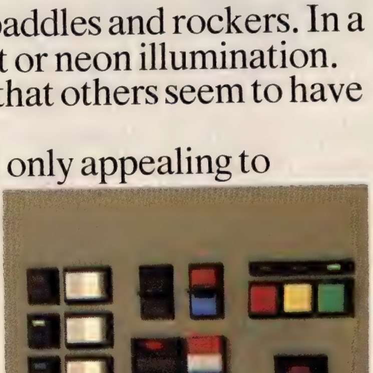
But what really makes AML unique is a small detail that others seem to have overlooked.

The people who use them. Which is why they're not only appealing to fingers, but other parts of the body as well.

That isn't to say we've neglected the person who puts the panel together. Because AML has single level termination for easy wiring and low installation cost. And electrical flexibility that ranges from solid state to electronic and power duty control.

With AML, you clearly design panels around people who use them, and not just their fingers.

For details, and the location of our sales offices and distributors around the world, write MICRO SWITCH, Freeport, Illinois 61032. Or call 815-235-6600.



MICRO SWITCH
a Honeywell Division

CIRCLE NUMBER 52 FOR DATA

sembly language, to improve documentation and facilitate programming. Program development is faster and the finished program is easy to follow six months later when a bug emerges or the program must be updated.

Complex programs can take several hours of assembly time on a computer; a 50% reduction in this computer time represents a significant improvement in programmer productivity. Products currently providing such improvements include the ASM86 from Intel, National's Starplex assembler and Zilog's PLZ/ASM.

7. Because of stand-alone emulators like the Millennium 2000, any computer system can develop software code to take on an in-circuit emulation function. The emulator operates the target system in real-time.

8. Zilog's PDS-8000 development system offers hard-disk storage and supports program development of the company's Z8000 16-bit microprocessor.

Improvements in assembly time are also the main feature of the AMC MACRO8000 product, which completes assembly in one pass of the source code. Other assemblies require two or even three passes.

Pseudo operations, by Intel, AMC and National, are directives that control assembler operation. They are called "pseudo" because they do not generate object code. With pseudo codes, the operator can perform, say, conditional assembly; the directive IF-THEN-ELSE lets the assembler decide whether or not to process certain code, based on a present condition.

An assembler that features high-level language compatibility gives the user control over real-time and I/O processing and can produce very efficient code—for example, Zilog's Z8000 PLZ/ASM. Software executes on Zilog's new PDS-8000 Development System (Fig. 8).

What have they done lately?

Software and hardware support are provided by the dedicated supplier (chip maker) to fulfill the needs of designers using a specific product, or by the universal development system builder for a range of products.

Dedicated suppliers are Motorola, Synertek, Rockwell, Advanced Micro Computers, AMI, National and Intel. Motorola calls its new development system the EXORset 30 (Fig. 9). It supports program development and hardware debug for the company's 6809 microprocessor. (Electronic Design, April 26, 1980, p. 238). Synertek offers a low-cost development system, the MDT1000 for the 6502 microprocessor (Electronic Design, Oct. 11, 1979, p. 212).

Rockwell has upgraded software on its System 65, offering a relocatable assembler and linking/loader

9. Motorola recently announced its EXORset development system that provides hardware and software support for the company's new microprocessor, the 6809. In addition, the EXORset can serve as a node in a larger EXORmacs system.

Solid State Scientific

Custom LSI

Name ____________________

Title ____________________

Address ____________________

____

Phone ____________ Ext. ______

My Application is ____________________

____

Preferred Technology ____________________

____

EID 5/10 Custom

Custom ICs can save you money. 98% of our customers save money with our custom MOS/LSI circuits. That's why they come to us. They save with higher reliability, reduced labor and materials costs, reduced problems at the board and system level, fewer parts and lower warranty costs. If you want savings like this—give us a call.

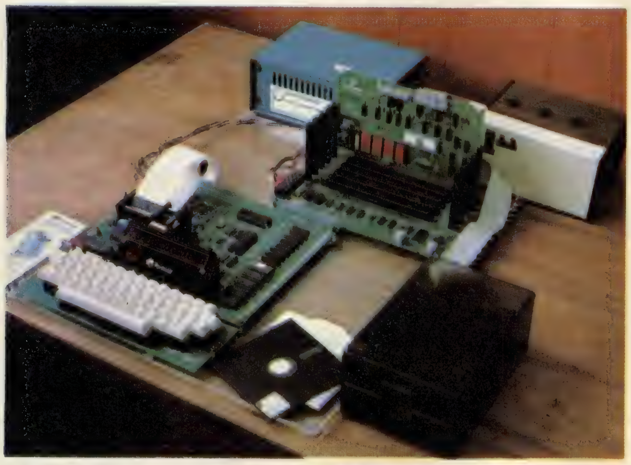
Our track record is proven. Whether your application requires long battery life, high packing density, high noise immunity or high speed, our design/production team can fill that need. We produce on time—within budget. And you will not have to muddle in big company bureaucracy. You talk to the design engineers at every stage of production. With our tight, independent quality assurance program, we build in reliability everytime—and deliver it on time.

Want to know more? Send in the above coupon to Solid State Scientific, Montgomeryville, PA 18936, or call 215-855-8400, ext. 274.

Solid State Scientific

along with Basic resident in the operating system. In addition, a low-cost development board called Expo is available for Rockwell's PPS family of microprocessors. Expo lets the designer develop programs on the System 65 (Fig. 10), then download via the Expo board and an RS-232 interface, to a PPS microprocessor.

AMC supports the Z80, 8080, 8085, and 8048, 49, 21 and 41 microprocessors with the AmSYS 8/8800 In-Circuit Emulator Subsystem. Cross-assemblers from AMI give software support to the S2200 microprocessor, as well as the S6800 and S9900. The software will run on the company's MDC-100 (which they no longer sell) and on the Tektronix 8002A or Motorola EXORciser systems.



10. The latest improvements to the System 65 from Rockwell is an operating system that offers a relocatable assembler and resident Basic.

11. New capability recently added to the Tektronix 8002 provides software support for three 16-bit microprocessors —the 8086, Z8000 and 68000. The system's support package will eventually include hardware support for these products.

From Texas Instruments comes a low-cost TM-990/302 Software Development Board. When the board is married to a terminal, power supply and TM990/100 or TM990/101 microcomputer board, software for the 9900 microprocessors can be written in assembly language or a new Power Basic language.

For its Starplex system, National has Pascal, PL/M, and an in-system emulator for the NSC800 microprocessor; it plans similar support for the high-performance, 16-bit NSC16000. One newly announced Intel capability is a group of standard packages, each of which provides canned software for statistics, string handling, real-time process control and the like.

Among universal MDS suppliers, companies with new offerings include Hewlett-Packard, Tektronix, E-H International, GenRad Futuredata, Cyber Systems Inc., and two suppliers making development systems for industrial process-control program development—Distributed Computer Systems and Xycom. From HP comes five new relocating macro assemblers to support the 6805/6809, 8048/8021, 9900, 1802 and F8/3870. Tektronix has rounded out its 8001/8002 (Fig. 11) product line with support for the 68000, Z8000 and 8086, which it will introduce in stages. Real-time prototype analysis and in-circuit emulation capabilities will culminate the product line. For 8-bit microprocessors, the company provides complete real-time software and in-circuit emulation for the entire 8048 family, including the 8041A and 8022.

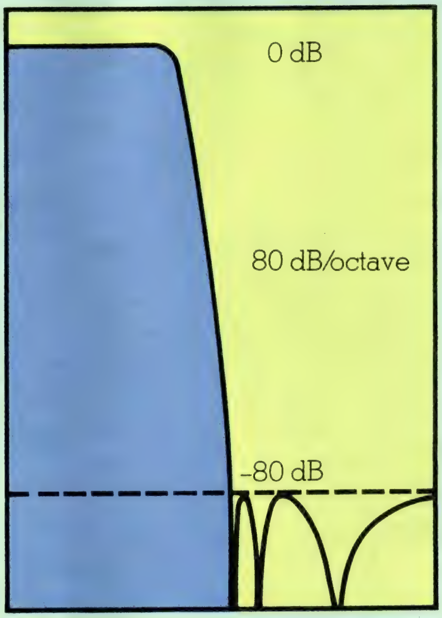
E-H International entered the universal-system market with its MicroSupport Development System. It has readied a Z80A Emulator; 6800 and 6802 emulators are imminent; and a Z8000 emulator is scheduled for the end of the year.

At this year's Electro, GenRad Futuredata introduces hardware and software support for the 6809 microprocessor. The software includes a relocatable macro assembler and Pascal and Basic compilers. The hardware includes a 2302 slave emulator for full-speed 2-MHz emulation.

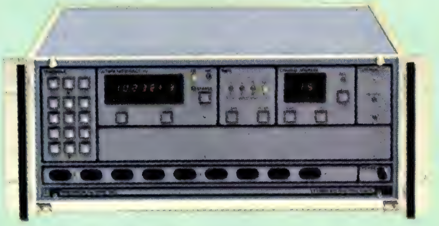
Cybersystems Inc. has created a development system called DACS 5100 (ELECTRONIC DESIGN, Jan. 4, 1980, p. 168). The product features a 72-line "cyberbus," which enlarges the pool of compatible I/O boards for tailoring a microcomputer to its application.

Two systems help to develop programs for industrial process-control applications. Distributed Computer Systems offers the DCS/80. The 3900A RAC PAC Host/Development System from Xycom develops programs in no less than three high-level languages: Basic, Pascal and Fortran.□

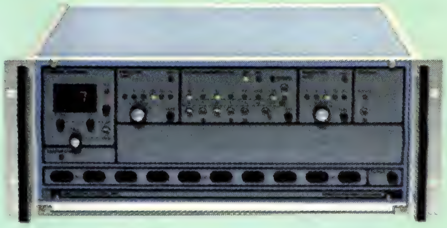
BEGONE CURSED ALIAS



Precision 616
124 programmable cut-off frequencies.



Precision 636
Two models: 4092 or 6141 cut-off frequencies.



Precision 416
Combined filter and amplifier. 62 cut-off frequencies.

You want analog data to come clean for digital conversion.

We keep extending the Precision ways to do it with signal conditioners, amplifiers and filters.

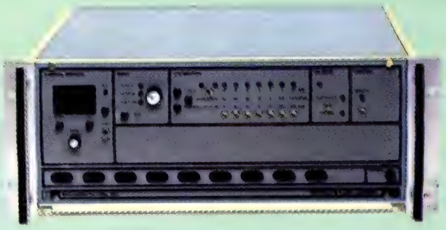
All Precision anti-alias filters have elliptics with 80 dB/octave attenuation. All come with time delay filters superior to Bessel. All have typical phase match of ½°.

All Precision instruments are programmable. All interface with mini, micro or GPIB. All have 16 channels, except the 602.

Call Don Chandler,
607-277-3550, for detailed specifications.

Precision 602
Two channels. 124 cut-off frequencies.

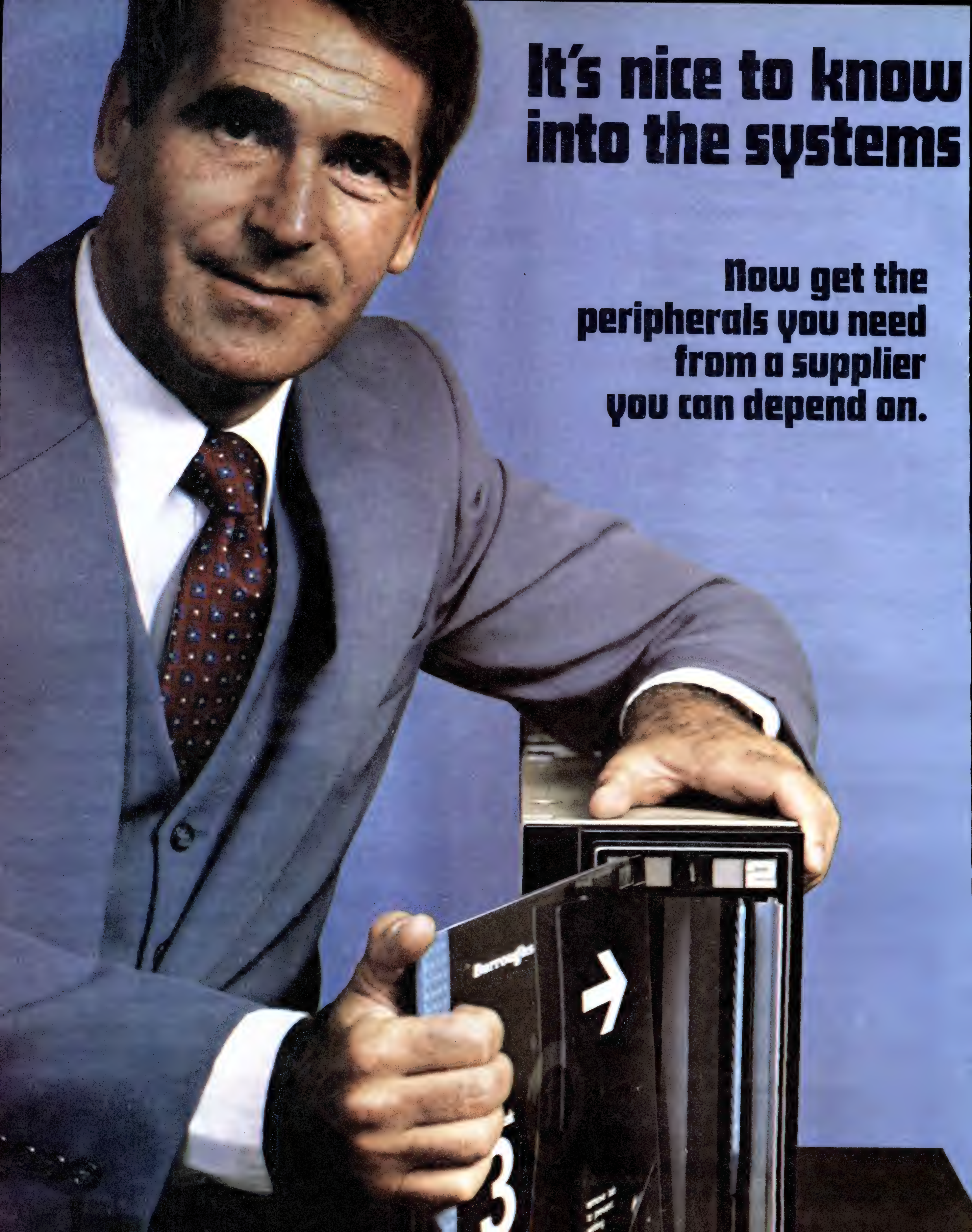
Precision 216
16 channel automatic/programmable gain amplifier. 300kHz bandwidth.



Precision 316
Calibration and conditioning for charge, voltage and strain inputs.

PRECISION FILTERS, INC.
303 W. Lincoln, Ithaca, N.Y. 14850

CIRCLE NO. 54



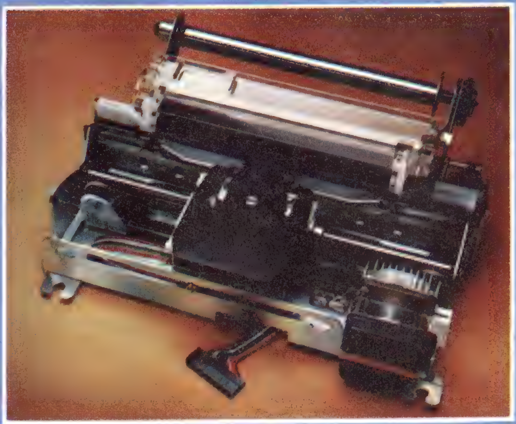
It's nice to know
into the systems

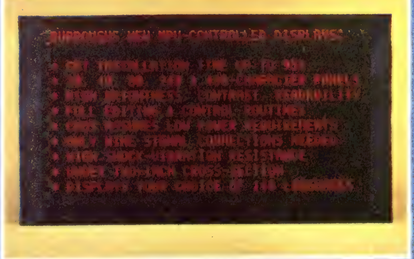
Now get the peripherals you need from a supplier you can depend on.

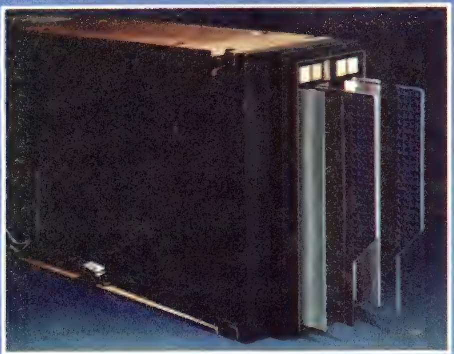
you've built Burroughs quality you've put your name on.

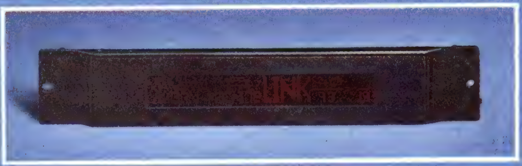
As an OEM systems decision maker, you may not be aware that Burroughs peripherals are available to the OEM. In fact, Burroughs now offers a growing line of OEM peripherals including floppy disk drives, fixed disk drives, printers, displays and many others. Rugged. Dependable. And backed by the Burroughs warranty. With worldwide production facilities to assure your supply.

For additional information, call or write **Burroughs OEM Marketing,** Burroughs Place, Detroit, MI 48232 (313) 972-8031. In Europe, Langwood House, High Street, Rickmansworth Hertfordshire, England. Telephone Rickmansworth (09237) 70545.









Burroughs

CIRCLE NO. 55

Information. Yours for the asking. A complete library of technical information to keep you current with electronics wire and cable.

This represents state-of-the-art solutions to everyday wire and cable problems. And they represent the state-of-the-art wire and cable company, Brand-Rex.

Brand-Rex is the largest and most diversified wire and cable supplier to the computer, peripheral equipment, commercial, military and business machine markets. Brand-Rex developed proprietary products that are now standard problem solvers for the electronics world... in a wide range of wire and cable types and constructions. We provide our customers a single "one-stop" supply source. And give design engineers one product line that achieves maximum performance without compromising physical, thermal or electrical requirements.

Brand-Rex meets the toughest standards in the industry. All products are UL-listed. Many have joint UL, CSA recognition and are "OSHA acceptable." *And they are MIL-Spec.*

Wire and cable problems. We've got the solutions all wrapped up and waiting for you. *In these state-of-the-art brochures.* Fill in the coupon, and we will send you the ones you need ...free.

BRAND-REX ELECTRONIC
PROBLEM SOLVERS FOR THE

Brand-Rex Company
Electronic & Industrial Cable Division
Willimantic, Connecticut 06226

Please send me the following Brand-Rex brochures:

☐ Back Plane Wire
☐ Business Machine Cable
☐ Coaxial Cable
☐ Flat Cable
☐ Hook-Up Wire
☐ Process Control Cable
☐ Signal Transmission Cable
☐ Technical Data

Name____________________
Title____________________
Company____________________
Address____________________
City____________________
State______________ Zip________

BRAND-REX
ELECTRONIC AND INDUSTRIAL CABLE DIVISION

Brand-Rex Company Divisions
Abbott & Co.: electrical harnesses for industry
Brand-Rex Ltd. (Scotland): wire and cable
Electronic & Industrial Cable Division: wire and cable
Nonotuck Manufacturing Company: copper wire
Pyle-National Company: electrical connectors
Telecommunications Cable Division: wire and cable
Teltronics, Inc.: telecommunications products
BRAND-REX COMPANY, A PART OF Akzona INC.

WIRE AND CABLE.
ELECTRONICS WORLD.

STATE-OF-THE-ART-SOLUTIONS. FREE.

CIRCLE NO. 56

Acquire and compute data...

and save as much as $40,000 in the process.

If you're about to spend $50,000 for a data acquisition/minicomputer system, consider this.

For as little as $10,000, you can buy the CompuDAS™ data acquisition/microcomputer system. It measures, monitors, compares, conditions, stores, displays and performs high level computations and data reduction . . . in real time.

Another big benefit of the versatile CompuDAS: it is equally at home in the lab or on the production line through a variety of available functional and packaging options. Its rugged construction allows use in production environment for on-line monitoring, data manipulation and control: Production personnel can operate it without difficulty.

CompuDAS software is a specifically developed version of Basic called DABIL,™ Data Acquisition Basic Interpretive Language. It is designed to simplify user programming (in English) while retaining minicomputer power, flexibility and speed. CompuDAS accepts analog and digital data from up to 500 data points and allows time sharing where as many as four individual programs can be run simultaneously. Of course, ITHACO provides all the applications assistance *you may* require, and we offer excellent service backup.

Get real-time performance and versatility along with real world savings. For complete CompuDAS data, read our new brochure. Call toll-free 1 (800) 847-2080 or (607) 272-7640, or use the reader service number. ITHACO, INC., 735 W. Clinton Street, Ithaca, NY 14850.

CompuDAS
. . . love at first byte.
T.M.

801A

ITHACO

CIRCLE NO. 57

Design

The HP System 45C enhances information flow between computer and user with high-resolution graphic displays—in 4913 shades of color.

Desktop computer clarifies graphics with vivid color

While color always lends interest and clarity to graphic displays, the 4913 color shades that are available on Hewlett-Packard's System 45 bring a new clarity and immediacy to interactive computing. Based on a powerful 16-bit mainframe, the desktop graphics unit is designed to solve difficult engineering tasks efficiently.

Its high-resolution display is augmented with alphanumerics and special I/O features. A light pen with two functional modes, eight soft keys, and a keyboard with 32 user-definable functions provide unparalleled display control. Powerful graphics software simplify picture manipulation. Often, a few lines of extended Basic suffice to clarify a complex graph with a meaningful range of colors. Monochrome hard-copy output not only supplies instant documentation, but facilitates comparisons with prior results.

The mainframe holds two custom NMOS 16-bit processors—a language processing unit (LPU), which executes interpretive-Basic programs, and a peripheral processing unit (PPU), which executes I/O tasks and interfaces with the graphics system (Fig. 1). Since the processors operate in parallel, the LPU never has to wait for external I/O functions —resulting in maximum system throughput.

The two processors access 449-kbytes of user RAM to support the manipulation of large data bases (such as chip-layout picture files and simulation data for interactive IC design). In addition, 160-kbytes of system ROM support editing and execution of HP's enhanced Basic language, including high-level graphics extensions and all system commands. The ROM gets the system ready to operate as soon as power is turned on.

Graphics-logic modules boost system throughput and resolution. The graphics memory for the 560 × 455 graphic raster stores 96 kbytes, divided into three 32-kbyte memory planes, providing 3 bits/pixel. Each plane contains video data for one of the three primary colors: red, green and blue. Combining the

Bill Hale, Project Manager
Bob Jewett, R & D Engineer
Harry Baeverstad, R & D Engineer
Hewlett-Packard
3404 E. Harmony Rd.
Fort Collins, CO 80525

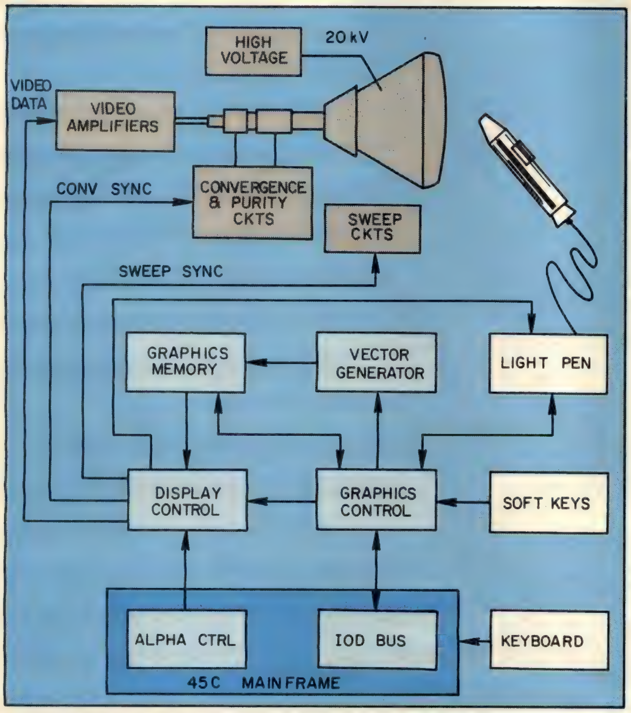
primaries yields yellow, magenta, cyan, white and black.

The key graphics element is the vector-generator, a 12-bit processor implemented with 2903-series bipolar bit slices. Using a "digital-differential" algorithm, the generator calculates pixel positions to approximate a straight line, given the x and y coordinates of the line's end points. Results are stored in the graphics memory, ready for transfer to the display control. A generalized description of a line demands fewer data transfers between the display controls and the PPU than would a pixel-by-pixel description.

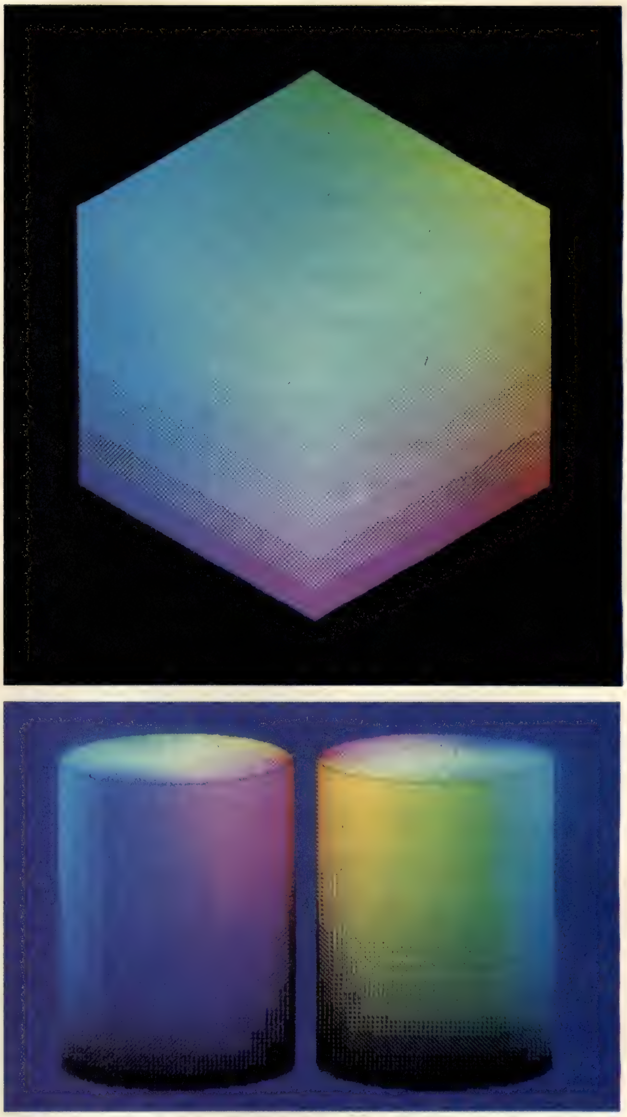
Solid graphics

Because the vector-generator produces lines so efficiently, it can fill in areas simply by drawing a set of parallel vectors—a quick method for generating solid, 3-D graphics. With the help of a user-addressable ROM, the vector generator controls the number of pixels illuminated per unit area, thus creating a picture much like the color photos in a newspaper. With 17 densities each, the primary colors produce up to 4913 shades. (See "4913 Colors from 3-Bits/Pixel!").

The vector generator not only controls shading, but also plots different combinations of dots and dashes, to yield eight types of lines that can be scaled in size



1. The System 45C graphics computer is a self-contained unit, consisting of a mainframe (red), powerful circuitry (orange) and very sophisticated display electronics (green). Inputs (blue) come from a keyboard, light pen and programmable "soft" keys.



2. A "color cube" presents one form of color selection for the System 45C. On a scale from 0 to 1, the user selects the intensity of the primary colors red, green and blue (top). With color selection by the "color cylinder" model, the hue corresponds to the angular dimension, the *saturation* corresponds to the radial dimension and the luminosity corresponds to the height (bottom).

over a 16-to-1 range.

Graphics can be displayed simultaneously with alphanumerics. Alphanumeric information dominates graphic information, so the user can revise or edit a display interactively. Displayed together, the 560 × 455 graphic raster and 720 × 450 alphanumeric raster create an array of 720 × 455 pixels. The combined raster has a 60-Hz refresh; emitter-coupled logic maintains the proper sweep rate with a 30-MHz clock. Therefore, the display shows high resolution and is flicker free, regardless of detail.

Soft-key labels on CRT

The dominant alpha-over-graphics technique allows the generation of labels directly above eight soft keys located along the bottom of the CRT bezel. These keys provide the same program functions as some user-definable keys on the main keyboard, but the dynamic feature simplifies interaction.

The keyboard provides the primary user input to the 45C. Special dedicated keys handle typing functions, system commands and display control; 32 user-definable keys aid typing and interactive program execution.

A high-performance light pen lets the user move a cursor quickly to any desired pixel. A small area around the cursor is interlaced with the raster sweep so that the pen "sees" only the tracking cursor. Sophisticated algorithms in the mainframe estimate and predict the pen position, acceleration, deceleration and change of direction, so that the captured cursor can follow the pen quickly and accurately.

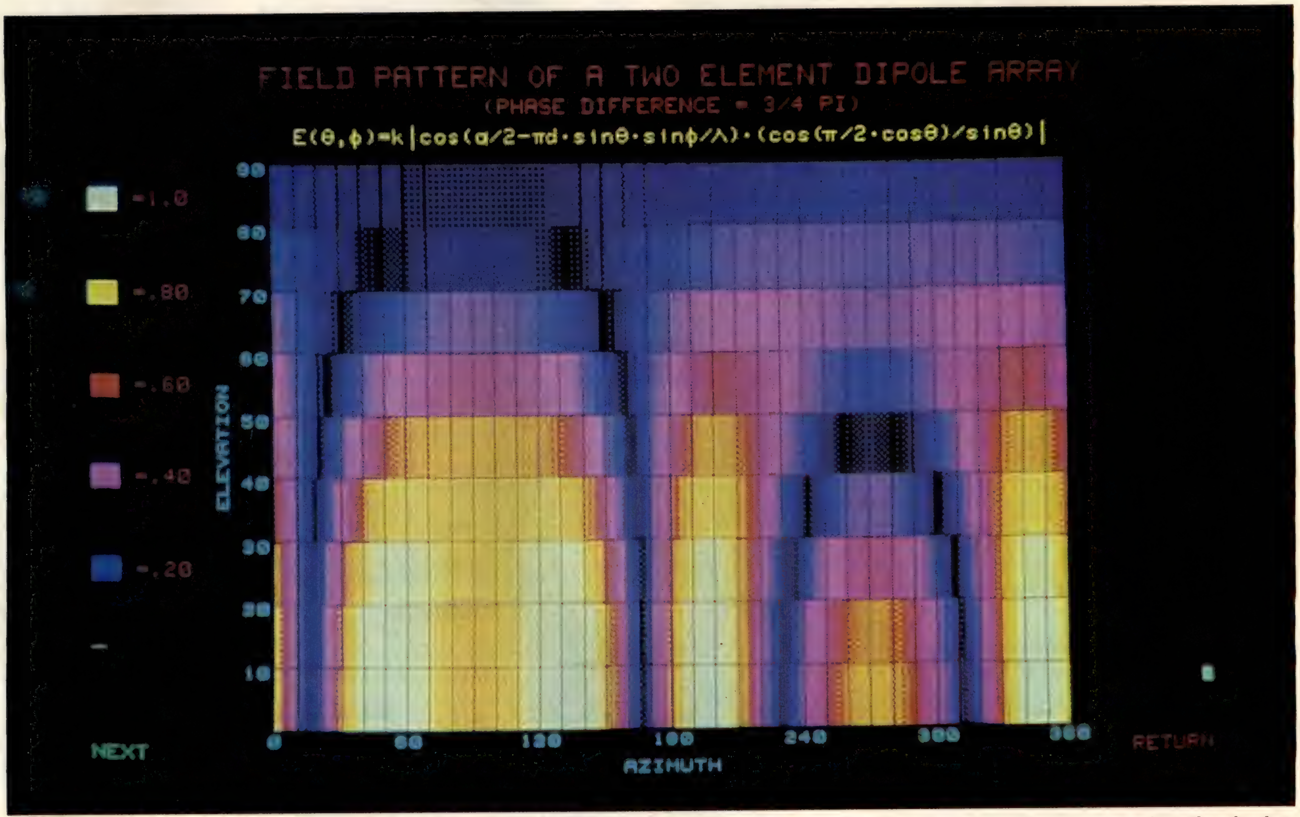
When not tracking, the light pen can also perform the normal "picking" function wherever video information is present. The tracking and picking modes give the light pen unprecedented versatility and greatly enhance user interaction.

A high-speed thermal printer provides hard copy of 80 character lines at speeds up to 480 lines/min. The thermal printhead contains 560 thin-film resistors as printing elements; monochrome copies of any of the three main colors or their logically ORed combinations can be generated.

Color models make the difference

Two geometrical color models—a color cube and a color cylinder—help the user to specify the colors (Fig. 2). Numerical, rather than literal, specifications allow continuity as well as accuracy in the color/shade selection. Since the parameters are numeric, the user may make small adjustments to a color very simply.

The color-cube model (Fig 2a) has, as its three axes, the three primary colors. The user specifies a color by providing a point, in 3-D space, which gives a mixture of red, green and blue, each with intensity



3. Color lends a third dimension to the field intensity plot of a dipole antenna around the nodes. Interactive computation and easy interpretation of the results can speed up the design process tremendously.

selectable on a scale from zero through one. For example, the basic statement:

AREA INTENSITY .5,.5,0

specifies a yellow (red plus green) of one-half intensity, with no blue.

The color-cylinder model allows the user to declare colors by specifying the three parameters of hue, saturation and luminosity (Fig. 2b). Hue is the angular measurement (the primary colors are red = 0, green = 1/3, blue = 2/3); saturation is the radial measurement, which specifies the extent to which the hue is mixed with white; and luminosity is the height dimension, which specifies the intensity per unit area. Again, the three parameters range from zero through one and specify a point in cylindrical coordinates. In the Basic statement,

AREA COLOR 1/3, 1, 1/2

the number 1/3 specifies a green hue, the 1 specifies full saturation (no white) and luminosity is 1/2.

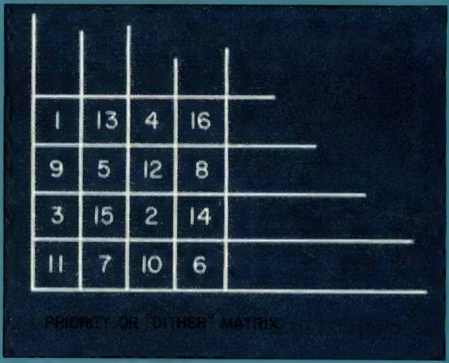
The color cube is quite easy to use because of its one-to-one mapping with the display hardware. The cylinder model is preferable to other models (double-ended cone, for example) because its three parameters are independent, allowing the full 0 to 1 range regardless of positioning on the model. Cylindrical coordinates are easier for the user to visualize, and contain no discontinuities.

Several statements allow the user to fill (or color) an area. Rectangles may be drawn by specifying a width and height from the current pen position and,

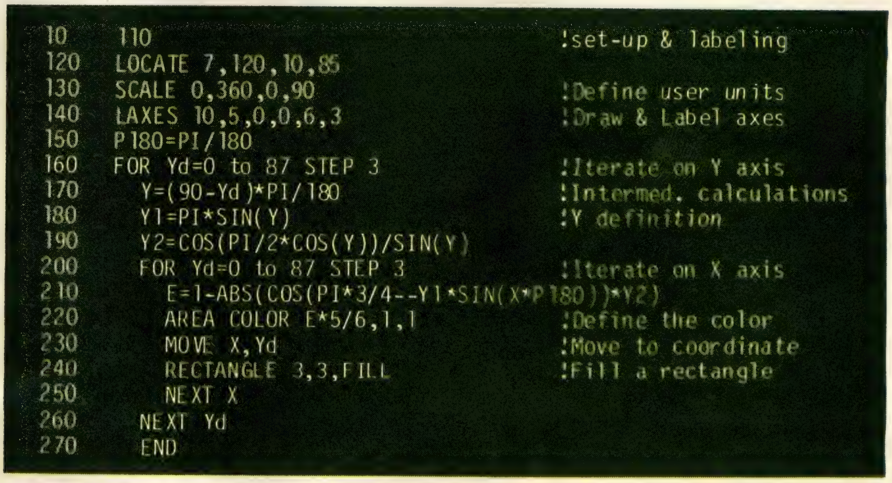
4913 colors from 3 bits per pixel!

The System 45C varies the density of illuminated pixels—not the intensity of the beam—to produce a continuous color scale from three primary colors. Red, blue and green combine to produce eight colors: red, green, blue, yellow, magenta, cyan, white and black. With 3 bits per pixel (in a 560 × 455 raster), the graphics-refresh memory requires 96 kbytes.

It would be possible—though very expensive—to get shading by assigning more bits per pixel. In the approach used by the System 45C, vector-generator hardware controls the shading functions: A ROM holds data representing a 4 × 4 "priority matrix" (see figure). It maps a 4 × 4 pixel array across the entire raster. For each of the primary colors, intensity levels of 0 through 16 pixels per 4 × 4 pixel area can be selected, yielding a total of 17^3 or 4913 shades, distinguishable to the user's eye.



1	13	4	16
9	5	12	8
3	15	2	14
11	7	10	6



```
10    110                                   !set-up & labeling
120   LOCATE 7,120,10,85
130   SCALE 0,360,0,90                      !Define user units
140   LAXES 10,5,0,0,6,3                    !Draw & Label axes
150   P180=PI/180
160   FOR Yd=0 to 87 STEP 3                 !Iterate on Y axis
170     Y=(90-Yd)*PI/180                    !Intermed. calculations
180     Y1=PI*SIN(Y)                        !Y definition
190     Y2=COS(PI/2*COS(Y))/SIN(Y)
200     FOR Yd=0 to 87 STEP 3               !Iterate on X axis
210       E=1-ABS(COS(PI*3/4--Y1*SIN(X*P180))*Y2)
220       AREA COLOR E*5/6,1,1              !Define the color
230       MOVE X,Yd                         !Move to coordinate
240       RECTANGLE 3,3,FILL                !Fill a rectangle
250       NEXT X
260     NEXT Yd
270     END
```

4. The field pattern of a dipole array is generated with this simple program in extended Basic. Upper-case and lower-case characters are available. The graph's coloring is specified on just two lines (highlighted).

Sophisticated hardware, too

It takes quality hardware to generate a color display free of aberrations and nonlinearities. To achieve large-screen performance in a 13-in. compact desktop unit, a high-resolution "delta-gun" tube was chosen. The shadow masks in such tubes boast four times as many color triads per unit area as conventional TV tubes or precision electron guns. To fully exploit the performance of the tube and generate a display free of flaws—even at close proximity—takes big improvements over normal TV technology.

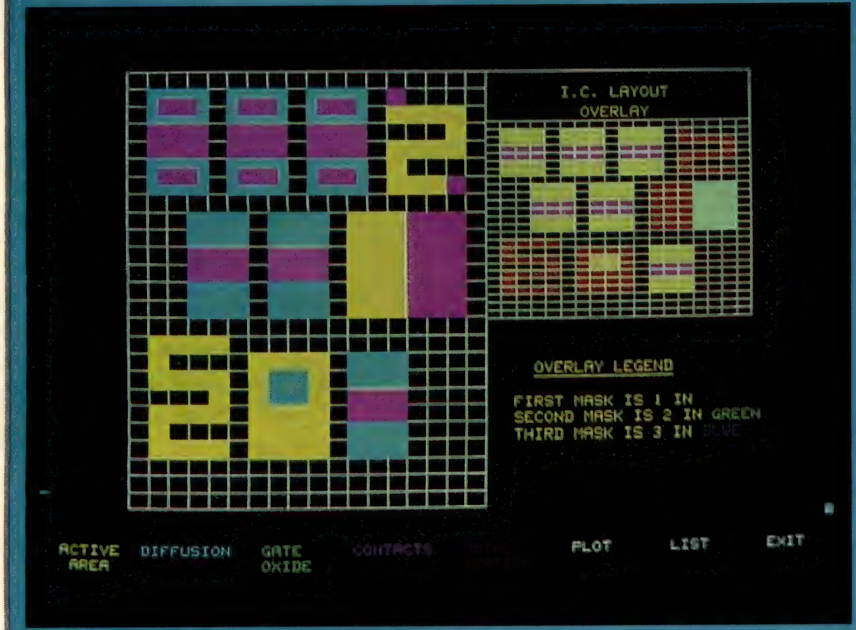
Many applications require the use of vector graphics—for instance the display for an IC mask layout. For such precision, even the varying distance of the tube face from the gun center poses a problem: normal saw-tooth sweeps do not create rectangular raster displays. Instead, the sweep ramp must be a section of a cosine wave to keep the velocity of the beam constant on the screen, regardless of its position. In addition, the horizontal sweep amplitude must be modulated parabolically at the vertical sweep rate and the vertical sweep at the horizontal rate to eliminate pincushion distortion along the sides of the display.

A feedback winding helps provide enough bandwidth in the deflection yoke to pass both vertical and horizontal frequencies and to eliminate the phase shift that results from winding resistance. But unlike normal TV implementations, which use saturable reactors, the System-45C deflection circuit permits precise shape and size adjustment of the parabolas so that the raster may be set to within 2% of its correct dimensions everywhere on the screen. Therefore, displays like a photomask appear to be constructed of parallel, straight lines at right angles. Operation at a 60-Hz scan rate of noninterlaced frames eliminates annoying flicker.

Another inherent problem with multiple-gun color CRTs is that the electron guns cannot be colinear. When the beams are bent by the deflection yoke, they can miss their destined location on the CRT face by a considerable amount. This lack of convergence causes annoying color fringes; in extreme cases the primary colors can even be distinguished. The design goal for the System 45C was to allow no visible display errors to muddle the data transmitted to the user, so elaborate circuitry was designed to provide convergence of the three beams.

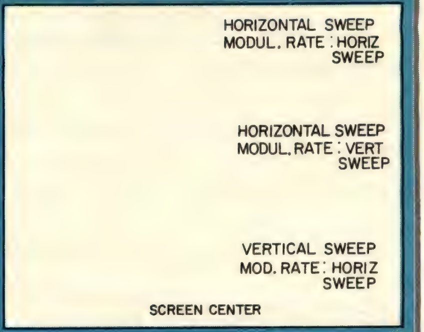
To generate convergence waveforms, the screen is divided into several areas and controls are switched into the circuit as the sweep moves through those areas. Quality op amps, multipliers and electronic switches permit the design of convergence circuitry that works not only on-axis but in the corners of the display as well. No fewer than 60 op amps cover 13 areas on the CRT face and all are separately adjustable from the front panel. Adjustment is easy with the help of software prompts to trim convergence. Each location can be adjusted independently and subsequent adjustments do not affect those already made.

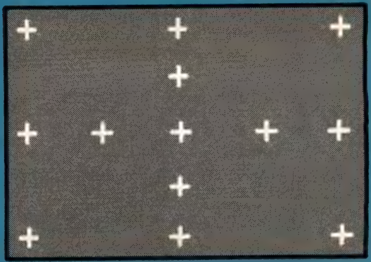
A large mu-metal shield covers the entire tube and yoke area, eliminating effects of the earth's magnetic field on both purity (absence of color fringes) and convergence. The user may move the System-45C freely in a room, without affecting its color performance.



OVERLAY LEGEND

FIRST MASK IS 1 IN
SECOND MASK IS 2 IN GREEN
THIRD MASK IS 3 IN BLUE





LOW COST,
HIGH ACCURACY

POSITION
TRANSDUCERS

CUSTOM DESIGNED
FOR OEM USERS

Farrand High Gain Inductosyn® linear and rotary position transducers custom designed to meet size, accuracy, and environmental requirements, can be delivered at $10.00 to $20.00 each in production quantities.

Accuracies to ±50 microinch, repeatability to ±20 microinch. Pitch to user specification; .010" to .020" typical. Auxilliary control signals, such as End of Travel or Track Location, can be included. Any substrate material, from cast aluminum to fiberglass tape. Thermal time constant adjustable to match user structure, eliminating inaccuracies during warmup.

Capacitively coupled. Ideal in strong magnetic fields. Interface easily to MOS. Use any excitation, such as 250 kHz user system clock. IC packages containing complete oscillator, error amplifier, and AGC available.

**Contact George Quinn,
(914) 761-2600 or Telex: 646640.
Or send now for technical bulletin.**

FARRAND CONTROLS
Division of Farrand Industries, Inc.
99 Wall Street Valhalla, NY 10595
(914) 761-2600 Telex: 646640

CIRCLE NO. 58

in a separate statement, a rotation angle, if desired, For example:

RECTANGLE 10,20,FILL

would fill a 10 × 20 rectangle (in current user units) with the color declared by either model. Regular polygons (equal-length sides) may be similarly drawn or filled. For example:

POLYGON 10,5,FILL

would fill a five-sided polygon which is ten user units from the current pen position to all corners. Irregular polygons are specified by placing the coordinates of the vertices in an array and then using the system's matrix-plotting facilities.

The data are organized by columns in the array. The first column contains the x coordinates and the second contains the y coordinates. An optional third column contains pen control information. Again, the polygon may be filled by adding the FILL parameter to the end of the statement. For example:

MAT PLOT A, FILL

would fill the polygon described by the coordinate vertices in array A.

The filling algorithm is a simple left-to-right scan algorithm. It sorts the intersections of the polygon's vectors and the current scan line in ascending order (left to right) and then fills from odd-numbered intersections to even ones.

The field pattern of a two-element dipole antenna array (Fig. 3) can be drawn using the Basic program shown in Fig. 4. Command words are in caps. User variables may include lower case (e.g., Yd, line 160).

The program size illustrates the system's power. Even for a rather complex graph, just two lines of code provide the coloring: In line 220 the desired shade is calculated, and line 240 fills the current rectangle.

Programs and data are stored on two 217-kbyte high-speed tape cartridge drives. They transfer data at an average rate of 1440 bytes/s at a tape speed of 55.9 cm/s; the search speed is 22.86 cm/s. Information is stored by file name and is accessed by a tape directory at the front of the tape. The directory is stored in mainframe memory until the tape's removal. Thus, the tape does not need to rewind to the directory section when new files are accessed—a feature that not only reduces wear on the drive and tape, but also speeds data access. □

How useful?	Circle No.
Immediate design application	541
Within the next year	542
Not applicable	543

ROLM's New ARTS Is A Fast Real-Time System. With WCS, It's Even Faster.

ROLM's Mil-Spec ECLIPSE® Computers now have a software/hardware combination that zeroes in on today's tough, real-time military applications.

The total package is fast, compact, and configurable. A real-time operating system designed for both time-critical and hostile environments.

ARTS (Advanced Real-Time System) expands the performance range of our Mil-Spec ECLIPSE line of computers by adding true real-time multiprogramming, multitasking capability. WCS (Writable Control Store) provides the additional hardware to access our microprogrammed processor and increase throughput for high-speed applications.

As a compatible subset to Data General's AOS (Advanced Operating System), ARTS is loaded with outstanding real-time features. It's configurable and modular, providing memory support from 64KB to 2048KB. ARTS can be memory-only or disk-based, depending on the needs of the application. Other features include: high order language support, (FORTRAN 5, PL/I, DG/L™ system programming language), memory resident file structure, and efficient interprocess communications.

The optional hardware part of the package, WCS, maximizes the computing power of our Mil-Spec ECLIPSE processors. And at the same time, it minimizes the critical path execution time for high-speed functions or processes. In time-critical operations, specialized functions can be tailored precisely to the application.

ROLM's Mil-Spec ECLIPSE Computers with ARTS and WCS give military system designers the optimum system. It solves today's real-time problems...with tomorrow's technology.

That's Why We're #1 in Mil-Spec Computer Systems

ROLM MIL-SPEC Computers

4900 Old Ironsides Drive, Santa Clara, CA 95050.
(408) 988-2900. TWX 910-338-7350.

In Europe: Muehlstrasse 19, D-6450, Hanau, Germany,
6181 15011, TWX 4-184-170.

®ECLIPSE is a registered trademark of Data General Corporation.
™DG/L is a trademark of Data General Corporation.

CIRCLE NO. 28

Fluke Portable Test Instruments

"Engineering designed this new counter with all the features our production people asked for."

You'd expect our production management to be biased in favor of our new 7250A Universal Counter/Timer. But when we challenged them, they told us why Fluke Counters are becoming favorites on lines everywhere.

"This new Universal Counter is just what we asked for. A bench-top basic function 80-MHz instrument with the measurement modes our people use most. A built-in switchable filter and a X1 to X100 continuously adjustable attenuator eliminate unwanted triggering. The input amplifiers feature the accuracy and reliability that only Fluke-designed thick-film hybrid circuits can provide. And Fluke's commitment to quality insures maximum uptime at a price that's right for the line – only $699 U.S."

Built for IEEE-488 system automation.

"We're installing new automated test procedures. And the 7250A Universal Counter fits right in. By adding the 1120A Translator and the 7250A's talk-only interface option, we can build an inexpensive IEEE-488 system. The 7250A also uses the unique Fluke Portable Test Instrument (PTI) design for latching our instruments together in a neat, uncluttered package."

Convincing evidence.

Our production managers are sold on our new 7250A. How about you? For more information call toll free **800-426-0361**; use the coupon below or contact your Fluke sales office or representative.

FLUKE®

IN THE U.S. AND NON-EUROPEAN COUNTRIES:
John Fluke Mfg. Co., Inc.
P.O. Box 43210 MS # 2B
Mountlake Terrace, WA 98043
(206) 774-2481
Telex: 152662

IN EUROPE:
Fluke (Holland) B.V.
P.O. Box 5053,
5004 EB Tilburg,
The Netherlands
(013) 673 973 Tlx: 52237

☐ Please send 7250A specifications.
☐ Please send information on Fluke's 125-MHz 7260A and 7261A Counters.
☐ Please send IEEE-488 Translator info.
☐ Please have a salesman call.

Name
Title Mail Stop
Company
Address
City State Zip
Telephone ( ) Ext.

For technical data circle no. 60

ED 15/80

Communication between a CPU and I/O devices on a multiplexed data/address bus depends on the interface. Along with standard devices, DEC offers six chips that work with the user's logic to form a custom interface for the LSI-11 bus.

Standard and custom hardware expand interface options

For its LSI-11 family, DEC has developed parallel, serial and custom interfacing devices that typify the methods for establishing communications between a CPU and its I/O support (Fig. 1). Premier among custom interfaces are the CHIPKIT chips; they work with the user's own logic to form a custom interface that can be more cost-effective and more compact than standard interfaces.

In DEC's CHIPKITs, predefined ICs provide basic interface functions to the LSI-11 bus. This technique requires substantially fewer components than designing from scratch with standard chips. Like the numerous ICs in standard serial or parallel bus interfaces, the six CHIPKIT chips must perform four basic functions:

- Address selection: The interface determines whether to participate in the next transaction.
- Control/Protocol: The interface determines its method of participation.
- Data transfer logic: The interface monitors control lines to determine whether data will be put on or taken off the bus.
- Interrupt: The interface informs the CPU that an I/O device wishes to interrupt the present program flow.

Other functions are also needed, but they depend on the type of interface and microcomputer application being implemented.

Family bus assures commonality

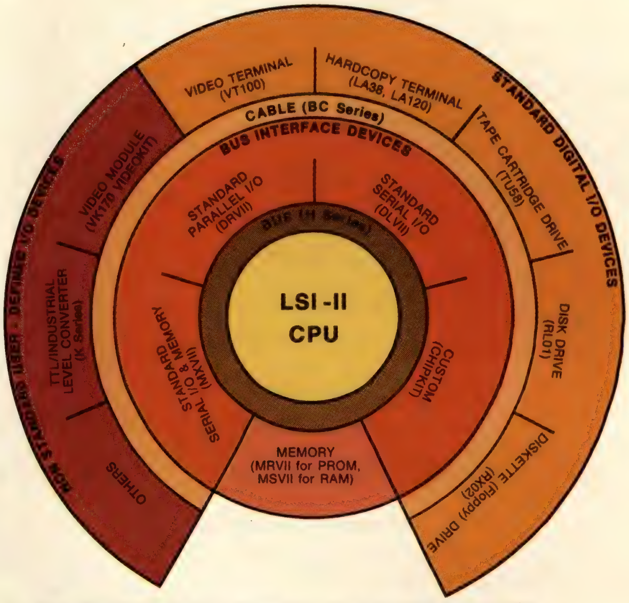
DEC's latest microcomputers are the LSI-11/2 and LSI-11/23. When either of these CPUs is packaged with a backplane and power supply in a rack-mountable box, it becomes a low-end member of DEC's PDP-11 family.

All LSI-11 microcomputers use the same bus architecture to assure hardware and software commonality throughout the family. The LSI-11 bus consists of 36 bidirectional and two unidirectional signal lines, some of which carry time-multiplexed information. The functional divisions are: 18 data/address lines (called BDAL); 6 data transfer control lines (such as BDIN and BDOUT); 3 direct memory access (DMA) control lines (such as BDMR and BSACK); 6 interrupt control lines (such as BIRQ and BIAK); and 5 system control lines (such as BINIT and BPOK).

I/O devices connect to bidirectional lines via high-impedance bus receivers and open-collector drivers. The asserted state occurs when a bus driver asserts the line low; the unasserted state is high.

DMA transfers between devices on the bus assume

Bruce D. Filgate, Senior Design Engineer
Charles F. Hanks, Senior Application Engineer
Philip J. Campaigne, Marketing Manager-Microcomputers, Accessories and Supplies Group
Digital Equipment Corp.
Merrimack, NH 03054


NON STANDARD USER - DEFINED I/O DEVICES
STANDARD DIGITAL I/O DEVICES
VIDEO TERMINAL (VT100)
HARDCOPY TERMINAL (LA38, LA120)
TAPE CARTRIDGE DRIVE (TU58)
DISK DRIVE (RL01)
DISKETTE (Floppy) DRIVE (RX02)
VIDEO MODULE (VK170 VIDEOKIT)
TTL/INDUSTRIAL LEVEL CONVERTER (K Series)
OTHERS
CABLE (BC Series)
BUS INTERFACE DEVICES
STANDARD PARALLEL I/O (DRVII)
STANDARD SERIAL I/O (DLVII)
STANDARD SERIAL I/O & MEMORY (MXVII)
CUSTOM (CHIPKIT)
MEMORY (MRVII for PROM, MSVII for RAM)
BUS (11 Series)
LSI -II CPU

1. Standard or custom bus-interface devices provide communication between the LSI-11 CPU and standard or nonstandard I/O devices.

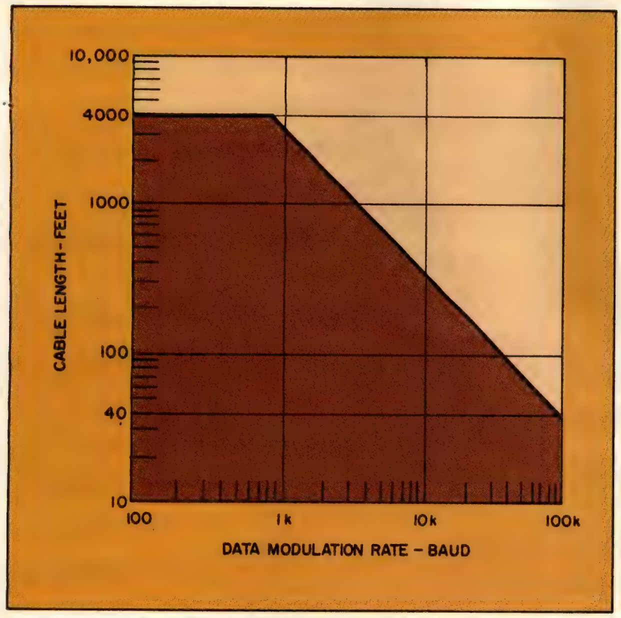
a master/slave relationship throughout each data transfer. The bus "master" (either the CPU or a DMA interface) controls the bus when communicating with any "slave" device. The transfer of bus data in (BDIN) and bus data out (BDOUT) is always completed with reference to the bus master. While controlling data flow, the master also provides time-out error management; it aborts the bus cycle if a slave device does not respond to transactions within 10 μs.

Programmable read-only memory (PROM) or random access memory (RAM) or both are linked to the bus in the same manner as the bus interface devices. Unlike classical computers, PDP-11 architecture does not distinguish between memory and I/O devices. That is, the same instructions address both I/O and memory.

All LSI-11 interface devices—both standard and CHIPKIT—are mounted on LSI-11 PC boards. Appropriate edge-connector pins are connected to the power plane on one side of the board and the ground plane on the other. The remaining contacts are terminated with a double row of wire-wrap pins for user-designated functions (on interfaces that provide for user-defined functions). Power requirements are 5 and 12 V. DEC provides cabling in assorted lengths to interface the LSI-11 modules with I/O devices.

Standard interfaces: parallel and serial

A parallel interface provides a one-word-wide (16-bit) data path between the bus and I/O device. Its control logic informs the I/O device when data are ready for transmission or when the CPU is ready to accept data. The 16-bit data input paths are separate from the 16-bit data output paths.



2. The maximum allowable cable length in feet for bit-serial transmission is a function of the data-transfer rate in baud (EIA Standard RS-423).

The DEC DRV11 parallel interface provides program-controlled data transfers at rates up to 40 kwords per second. Its control logic processes interrupts and generates vectors. The data are handled by 16 diode-clamped input lines and 16 latched output lines. Two 40-pin connectors on the PC-board are provided for connecting I/O devices.

A serial interface provides bit-serial communication, according to EIA Standard RS-232, RS-422, RS-423 or 20-mA current loop. It receives parallel data from the bus and converts to bit-serial form for an I/O device. Conversely, it converts serial I/O data to parallel form for transmission to the bus.

DEC's DLV11 serial interface provides several selectable crystal-controlled data transfer rates from 50 to 9600 baud. The serial selectable format includes stop bits, data bits and even, odd or no-parity bits.

If a microcomputer and I/O device are installed (relatively) close, a parallel interface may be appropriate. For longer distances a serial interface may be the best choice. Fig. 2 (from EIA Standard RS-423) gives maximum cable length in feet for serial transmission as a function of data transfer rate in baud. For example, at 9600 baud with serial transmission, the cable length should be no greater than 400 feet.

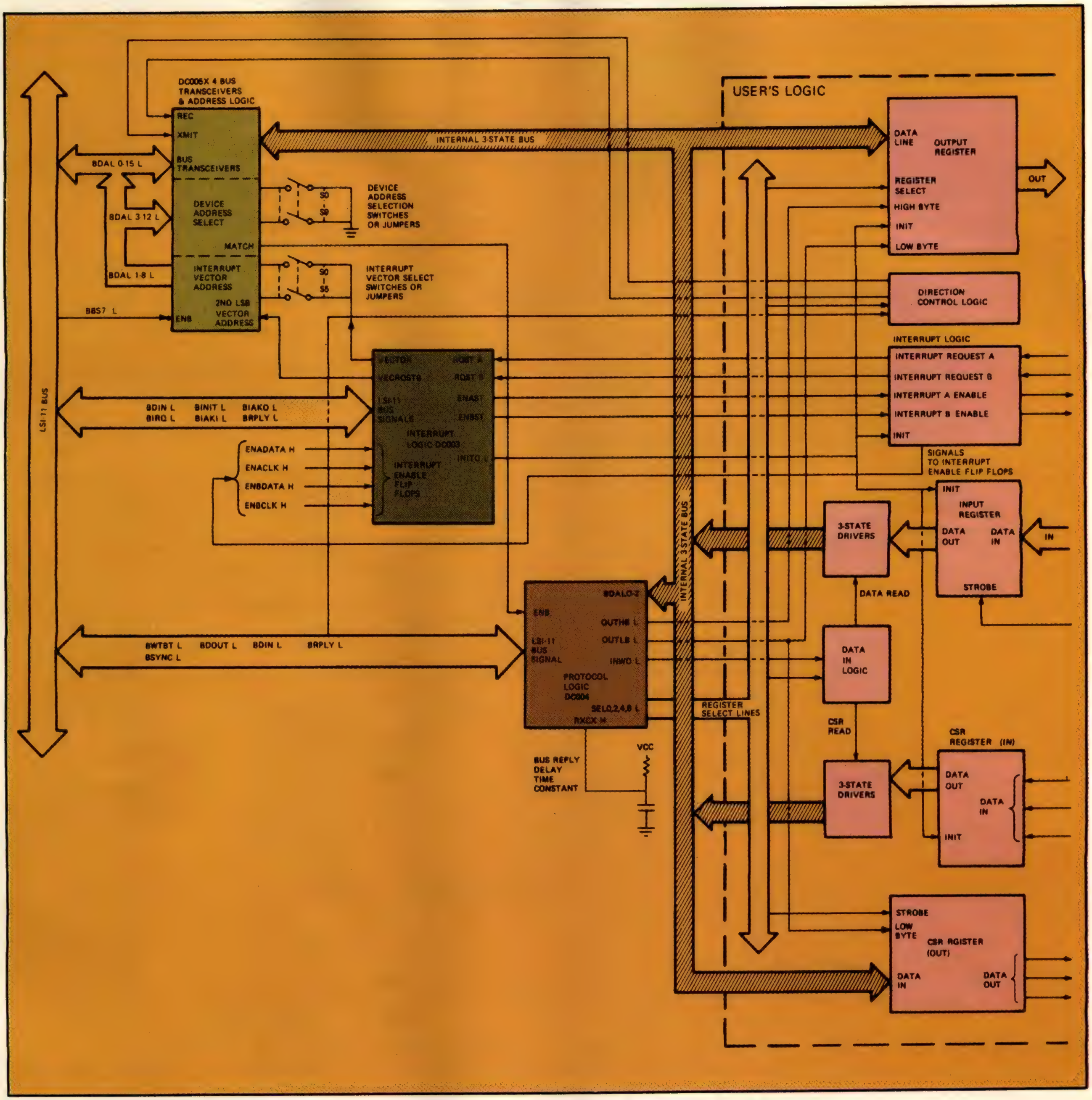
The ICs in DEC's CHIPKIT interfaces reduce design time, component count and system cost. The costs of assembly, testing, inspection and inventory for the interface are also reduced. Because the basic interface functions are distributed among several fixed-chip configurations, design efforts can be concentrated on the specific logic circuitry needed by a specific application. Just one of the CHIPKIT chips (the DC005) performs all the functions of six or seven standard ICs. The complete CHIPKIT interface can be mounted on a single PC board.

Program control and DMA CHIPKITs

Two CHIPKIT interfaces are currently available. They are program control and direct memory access (DMA). A standard program-control interface is used when the data-transfer rate is 50 kwords per second or less and when CPU overhead is available to handle service routines for each data transaction. A standard DMA interface transfers data at faster speeds and conserves CPU overhead.

The standard program-control and DMA CHIPKITS come in several forms: (a) chip sets, (b) chip sets with wire-wrap module and cable and (c) tubes of specific chip types. The chip set with module and cable is for prototyping and initial production; the chip sets alone and the tubes of individual chips are specified for volume production.

The custom CHIPKIT program-control interface consists of six chips: one DC003 interrupt chip, one DC004 protocol chip and four DC005 transceiver/ad-



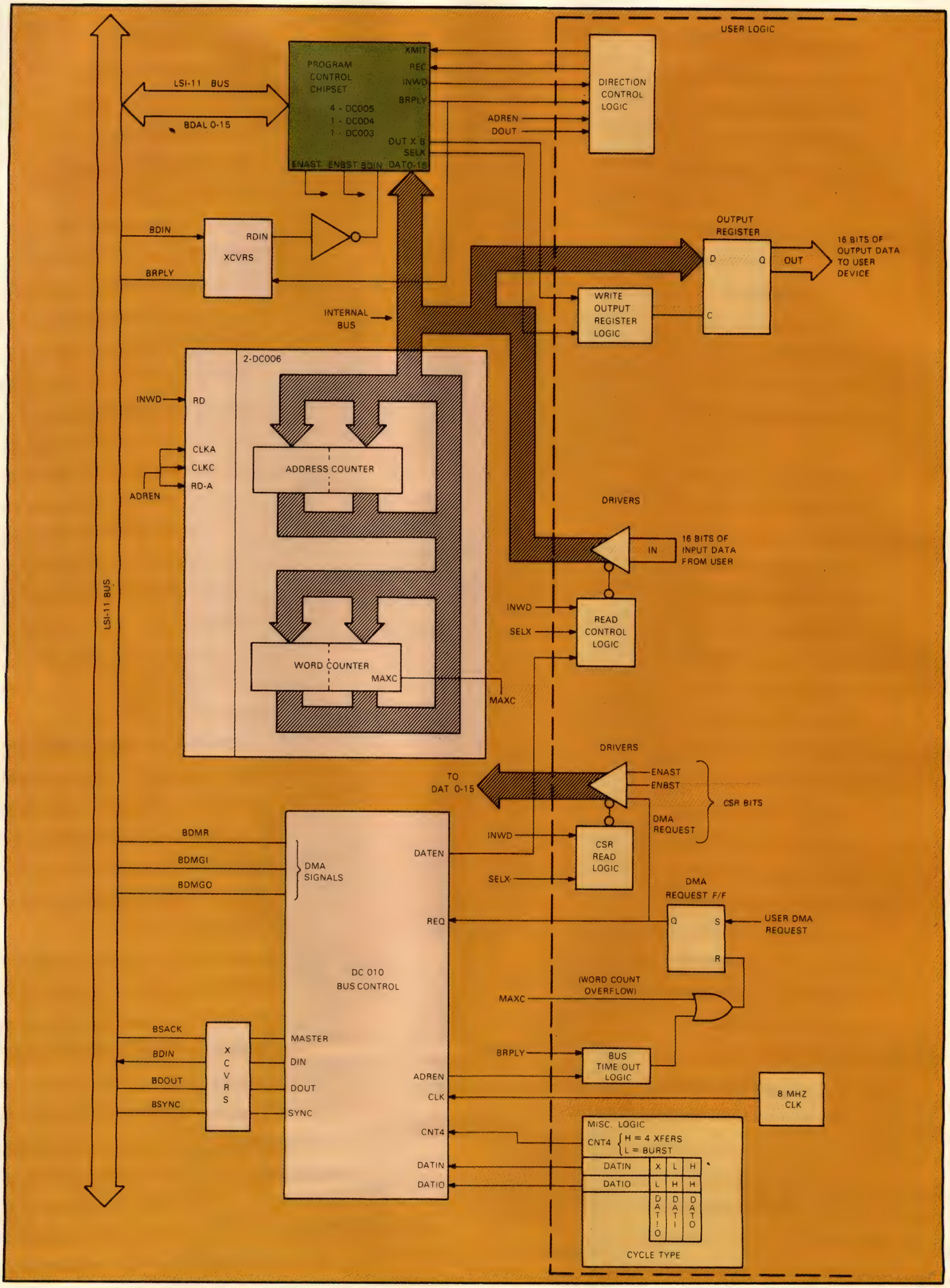
3. Individual CHIPKIT program-control interface chips connect the LSI-11 bus and the user's logic in a custom program-control interface.

dress-decoder/vector-select chips. Fig. 3 shows how these chips might be combined with the user's logic in a typical program-control application. In other applications, the designer would probably use the same four transceiver chips and vary the interconnections with the user's logic.

Custom interfacing: a chip-by-chip account

In Fig. 3, the user's logic suits the particular I/O device but has components that are common to all interfaces. The input and output control and status registers (CSRs) contain all the information needed to establish communications with the I/O device. (Some I/O devices may not require 16 status bits; others may require more. For more than 16 bits, additional registers must be included). In this example, interrupt-request and interrupt-enable functions have been assigned to the user's interrupt logic. The data-output and data-input registers in the user's logic temporarily store data being transferred into and out of the CPU (some users may prefer not to have an input register at all and feed their data directly to a three-state driver).

The DC003 (low-power Schottky) performs interrupt transactions between the user's device and the LSI-11 bus. The chip provides A and B interrupt



4. **Also combined with user's logic, this custom CHIPKIT DMA interface requires all the CHIPKIT circuitry of Fig. 3 (green block) plus two DC006 word-count/bus-address chips and one DC010 DMA bus-control chip.**

channels, with the A channel at the higher priority. The user has access to the enable flip-flop outputs and the buffered BUS INIT, which initially disables interrupts. The VECTOR output to the DC005s gates the interrupt vector address directly onto the bus. Interrupt B generates the second least-significant bit of the vector address (VECROSTB H).

The DC004 (low-power Schottky) functions as a register selector, controlling data flow in and out of four word registers (maximum). It monitors the DC005 buffered version of the BDAL lines 0, 1 and 2 to determine which register address has been placed on the bus, and monitors BDOUT and BDIN to determine the type of data transfer (DATO or DATI). An RC delay circuit slows the response of the interface to data-transfer requests, if desired. The chip also includes high and low byte output-select lines (OUTHB L, OUTLB L) and an input-select line(INWD L). Receivers and drivers are provided on the chip for all bus interface signals.

The DC005 (low-power Schottky) functions as a bidirectional buffer between the LSI-11 bus and the interface's internal three-state bus. This chip also includes a comparison circuit for selecting the device address (3 bits of comparison per chip) and logic to produce interrupt vector addresses. The DC005 includes drivers and receivers for the LSI-11 bus and the internal three-state bus.

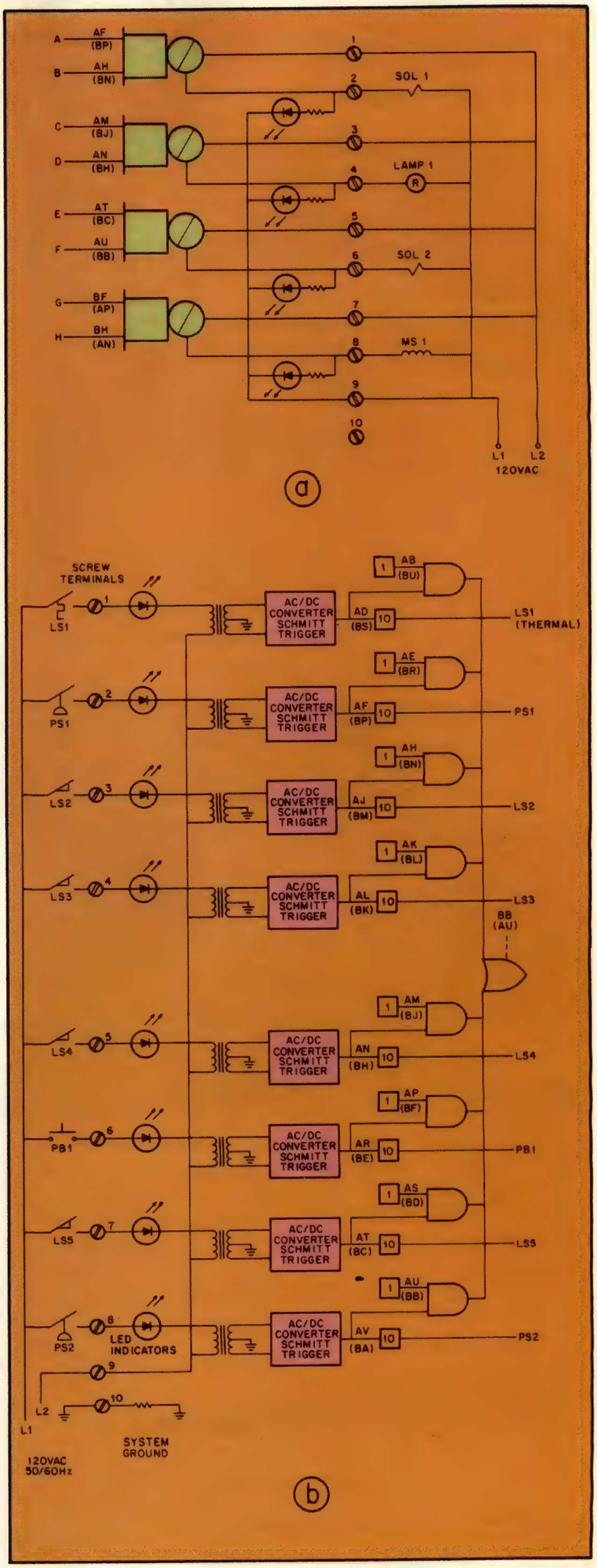
The DMA CHIPKIT interface uses all the program-control interface ICs, as well as two DC006 word-count/bus-address chips and one DC010 DMA bus-control chip. Fig. 4 shows these chips in a typical DMA application with user's logic.

The DC006 (low-power Schottky) connects to the three-state side of the DC005 transceiver. The 8-bit address and word counters may be cascaded to increase register implementation. Each counter is separately loaded and incremented, and both may be cleared simultaneously. The count overflow is brought out to the user. The DC006 is controlled by the protocol (DC004) and DMA (DC010) chips.

The DC010 (low-power Schottky) performs the "handshaking" required to gain control of the LSI-11 bus. A control line (CNT4) gives up the bus temporarily after just four transfers (H) or controls the bus for the entire transfer (L). Two other inputs (DATIN and DATIO) permit selection of cycle type (DATI, DATO, DATIO). The chip uses an external 8-MHz clock to generate LSI-11 bus signals for DIN (BDIN), DOUT (BDOUT), SYNC (BSYNC) and SACK (BSACK).

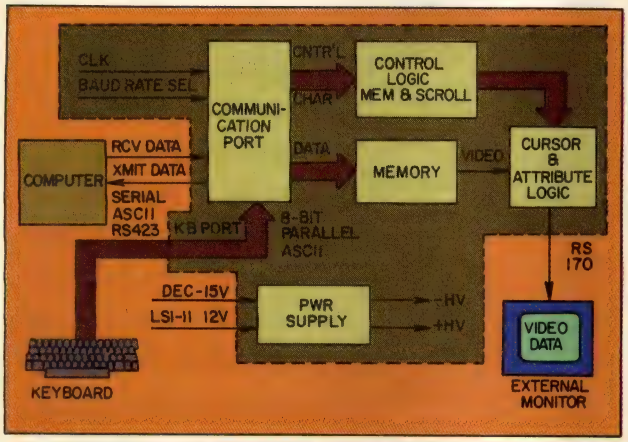
Modules make "special" simple

Nonstandard I/O devices can be interfaced entirely by the user with the IC components just described. But DEC also provides predefined logic modules that perform bus interfacing functions for various I/O

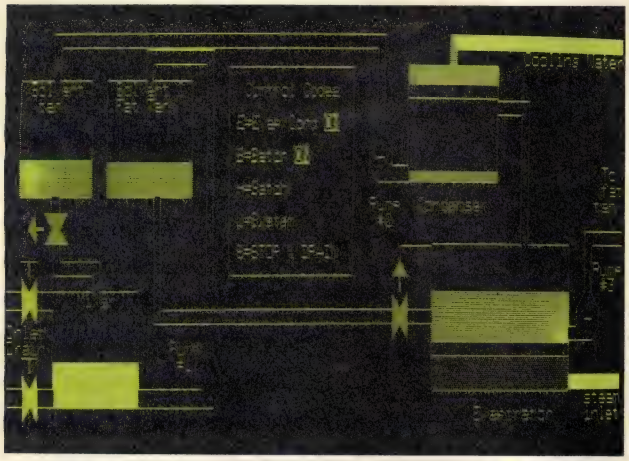


5. An output connection using DEC's K Series TTL/industrial-level converters (a) controls solenoids, lamps and motor starters. An input connection (b) monitors eight 120-V ac inputs while converting them to 0 and 5-V dc logic levels.

devices. As with CHIPKIT bus interfaces, these modules combine with the user's circuitry to form a nonstandard I/O. One such multifunction module contains all the elements needed to implement a small system: 8 or 32 kbytes of RAM, enough ROM/PROM for bootstrap or program functions, a crystal clock, and two serial I/O ports. DEC also offers its K series of TTL/industrial-level converters and its VK170 VIDEOKIT serial video modules.



6. The VK170 VIDEOKIT module (inside dashed area) accepts serial ASCII-encoded data from a computer bus-interface device or parallel data from a keyboard terminal and generates a video output for external monitors.



7. Simple animated video displays, such as this schematic of liquid soap processing, can be generated with the VK170 VIDEOKIT module. Here, all dot positions in the 8 × 8-character cells are being used.

The TTL/industrial-level converters provide two major functions in I/O devices for industrial control and monitoring: high voltage/high current switching and noise immunity. Through control of rise and fall times, these converters eliminate noise spikes that are common to industrial applications. Some interference can be minimized by physically isolating the microcomputer and the noise source. Common-mode noise (introduced in both lines) may require either an optical isolator or a special transmission technique. Typical I/O for TTL/industrial-level converters are shown in Fig. 5 (DEC's K-series).

The VK170 VIDEOKIT video module (Fig. 6) accepts serial ASCII-encoded data for generating displays on external video monitors. It connects to any computer (DEC or otherwise) that provides serial communication according to EIA RS-423 or the DEC 20-mA current loop. The video module also accepts 8-bit parallel data from a keyboard. Data from the communications input port are sorted to form two internal streams: control characters to the control logic and data to the refresh memory.

The video display consists of 25 lines of 80 characters per line. The characters are generated within a 7 × 7-dot matrix in adjacent 8 × 8-character cells. Video attributes that are enabled character-by-character are blink, half-intensity and reverse video. Space is provided for a character-generator PROM or ROM which may contain user-defined character sets.

The module's character cell configuration permits the design of simple graphics along with alphanumeric characters. The animated monitor display of Fig. 7 shows liquid soap being processed through a series of production steps. Tank levels rise and fall, valves open and shut, and pump impellers rotate in the monitor display.

The video module serves well in spaces that are insufficient for standard video terminals; where the terminal must be portable or packaged with other hardware; or where no keyboard input is required (as in airport monitors for departure schedules). Its PC board can be plugged directly into the LSI-11 backplane or standoff-mounted for stand-alone applications. □

How useful?	**Circle No.**
Immediate design application	544
Within the next year	545
Not applicable	546

SYSTEM 19 NOW PROGRAMS MORE THAN 200 DIFFERENT PROMS WITH ONLY ONE SOFTWARE SELECTABLE MODULE.

Our new System 19/UniPak lets you program most MOS and bipolar PROM'S from AMD, Fairchild, Harris, Intel, MMI, Motorola, National, Raytheon, Signetics and Texas Instruments. UniPak's software assembles the programming algorithm and selects the correct socket for 16, 18, 20, 24 and 28-pin PROMS.

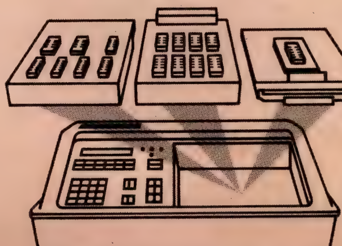
System 19/UniPak gives you design and purchasing freedom. This means you can select the best PROM for each application, and you can second-source for the best price and availability.

Semi-house approvals and easy calibration help maintain higher device yields. UniPak has earned written approval from device manufacturers. And easy calibration lets you keep performance within PROM manufacturers' specifications.

UniPak algorithms shorten programming time enhancing System 19's use as a production tool. UniPak is the first module to use a newly developed algorithm which makes it possible to program a 64K EPROM in less than half the time it takes to program a 16K EPROM using standard methods.

And the System 19/UniPak is easy to operate, with a minimum of operator training.

New System 19 concept is open ended to keep it state of the art. The System 19 is designed around a standard main frame and plug-in modules.

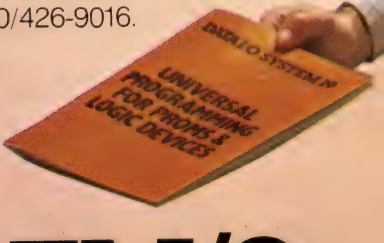


CIRCLE NO. 61

Modules available now include the UniPak, a gang programming pak for MOS devices, and a series of programming paks for logic devices and individual PROM families.

23 communication formats including six for development systems. Development systems, computers, teletypes and CRT terminals interface easily with the System 19. The System 19 accepts micro-processor instruction codes from Motorola, Intel, Tektronix, Fairchild, FutureData and other development systems without intermediary equipment.

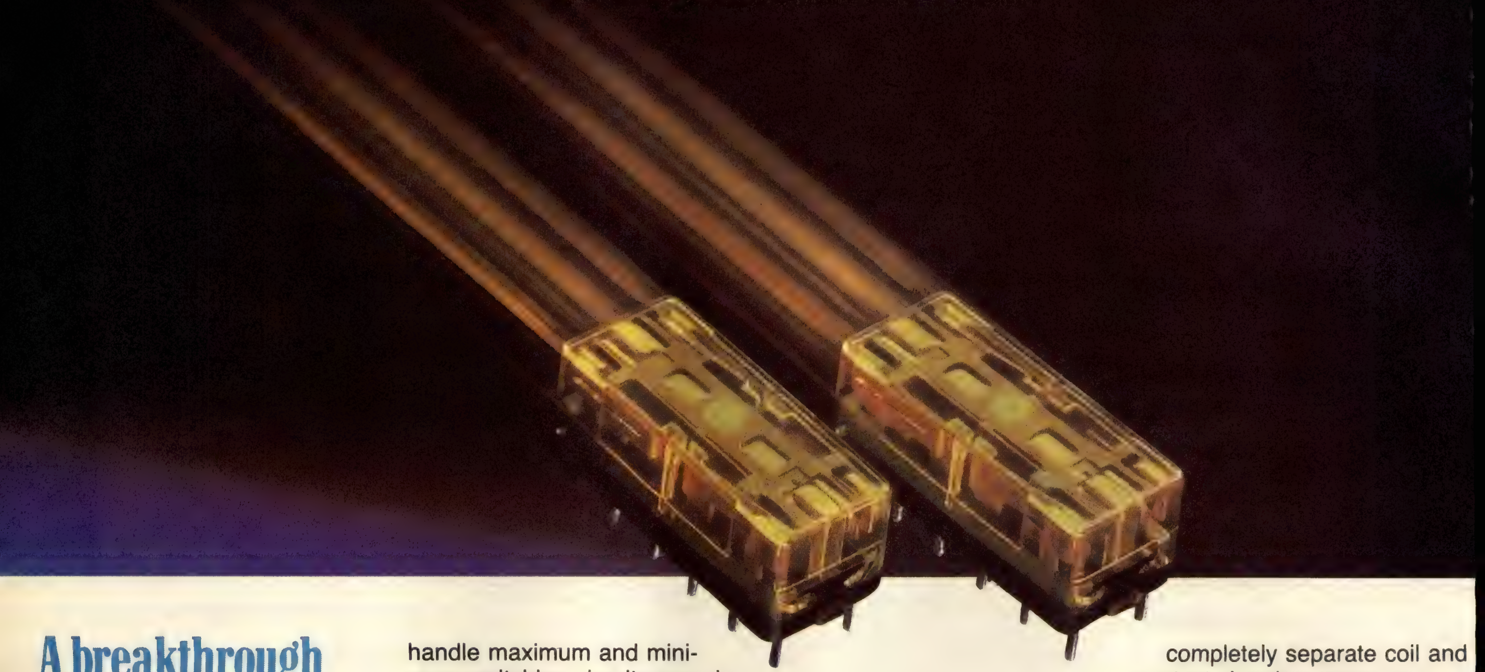
Let us show you the future. The new Data I/O System 19/UniPak is available now. To make arrangements for a demonstration or to get your free copy of this valuable 32-page book, circle reader service number or contact Data I/O, P.O Box 308, Issaquah, WA 98027. Phone 206/455-3990 or TOLL FREE: 800/426-9016.



DATA I/O

Aromat SE Amber Relays... a pure product of "relay efficiency."

$$\text{Relay efficiency}(\eta) = \frac{\text{The sum of all contacts' switching capacity (VA)}}{\text{Operating power(W)} \times \text{Volume(cm}^3\text{)}}$$



A breakthrough in relay efficiency.

The SE Amber relay's key to higher efficiency lies in greater miniaturization coupled with high reliability and greater switching capacity.

- **High sensitivity in small size.**

  $\left[\text{Operating power (W)} \times \text{Volume(cm}^3\text{)}\right]$

  The SE Amber relay's 4-gap balanced armature delivers a highly efficient polarized magnetic circuit–sensitive enough to be driven directly by an IC, in a space 28L x 12W x 10H mm.

Sensitivity

Pick-up power	100 mW
Nominal operating power	200 mW

Dimensions

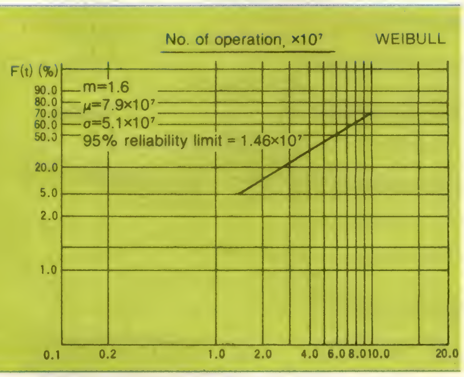
Volume	28L x 12W x 10H mm 1.102 x .472 x .394 inch	
Header area	336mm²	.521 inch²
Height	10mm	.394 inch

- **Wide switching range.**

  $\left[\text{The sum of all contacts' switching capacity (VA)}\right]$

  Switching is possible from 100μA 100mV DC to 4A 250V AC, thanks to the 4-gap balanced armature system and special multi-layer clad contacts. A single SE relay can handle maximum and minimum switching simultaneously.
- **High reliability and long life.** The balanced armature system with permanent magnets gives larger contact pressure. Bifurcated contacts and lower contact bounce add to contact reliability and expected contact life.
- **Amber design and construction.** Designed for automatic wave soldering and cleaning, the sealed SE Amber relay performs reliably under conditions where hydrogen sulfide, silicone and ammonia fumes prevail.
- **High vibration/shock resistance.** The balanced rotating armature provides great resistance to shock and vibration. Vibration resistance: 10 to 55G (amplitude: 3mm) Shock resistance: 50G (11msec.).
- **Varied contact arrangement.** SE relays are available with bifurcated contacts in 2a2b and 4a contact arrangements.
- **Multiple latching.** 2-coil latching types are available, in addition to single side stable types. Single SE relays have a latching capability with multiple contacts, one contact can control the circuit while the other can switch the load simultaneously.
- **Low thermal electromotive force.** Because the SE relay has completely separate coil and contact chamber areas, extremely low thermal electromotive forces are possible.
- **Dual in-line package arrangement.** This 2-track terminal arrangement allows easier component insertion, easier layout and identification of terminal locations, and simpler in-line checking.

Contact reliability
Test condition:
DC1V/1mA,
4 contacts in series
Detection level 10Ω
Sample: S4E-24V
Q'ty = 10



See Us At Booth #2315, 2317, 2319/Electro '80/Boston, MA/MAY 13-15

Relays for Advanced Technology

Aromat

Member of Matsushita Group

Aromat Corporation:
250 Sheffield Street
Mountainside, NJ 07092
(201) 232-4260

Mid-Western Office:
311 Lively Blvd.
Suite 1
Elk Grove Village, IL 60007
(312) 593-8535

Western Office:
10400 North Tantau Avenue
Cupertino, CA 95014
(408) 446-5000

Contact Your Aromat Representative or Distributor Today.

CIRCLE NO. 62

Because low-cost, 14-in. Winchester drives can transfer data ten times faster than floppies, the first criteria for building a controller— and for selecting each of its components— is speed.

Winchesters set fast pace for controller designers

Controllers for 14-in. Winchester drives must stand up to two challenges: fast data transfers (more than ten times faster than with floppy drives) and low cost (a cost per byte as low as 0.0006 cent). Because integrated circuits are not available, the designer must build these controllers from scratch. But the most important factors in selecting a microprocessor, track format layout, interface and command set for the controller all reduce to the two questions of speed and cost. Other design considerations—like those that complicate the selection of a floppy-disk controller—are settled by the Winchester technology itself.

Thus, the controller need not supply complex, interchangeable media protocols, because the Winchester drive is a fixed media. One drive, the Shugart SA4000, includes a data separator, an NRZ data interface and a clock track that virtually eliminates speed-tolerance considerations. The "ready" signal for the drive is simply an up-to-speed indication. However, a controller must employ bipolar circuits wherever disk data are handled (none of the current NMOS controller ICs are meant for transfer speeds that can reach 1.1 μs/byte); it must supply direct memory access (DMA); and it must make up for the lack of cylinder and head registers on the Winchester drive. These are the critical factors.

Choosing a speedy μP

The first task of the design engineer is to choose a microprocessor, based on the ratio between the byte time in the drive and the instruction cycle time of the μP. A hardware-assisted microprocessor requires a four-to-one ratio. When the data passes through to an unassisted microprocessor, a ratio of five or six to one becomes necessary. This ratio is equivalent to a 200-ns instruction time.

The only microprocessor generally available that accommodates a 200-ns cycle time is the 2900 bipolar chip (Fig. 1). Two 2900 μPs and a program sequencer (such as a 2910 or 2911) are required for 8-bit architecture. The two processor chips plus the sequencer yield 25 bits. With external REG control and BRANCH code, they give a word length of 28 bits.

One alternative to the 2900 and the bit-slice method is the use of an NMOS microprocessor (such as the 8080 or 6800) and a hardware sequencer. The instruction cycle time of the microprocessor can be much slower than the drive's byte time, because the sequencer handles the speed requirement of the drive and feeds data to the DMA logic. The block diagram in Fig. 2 illustrates this design.

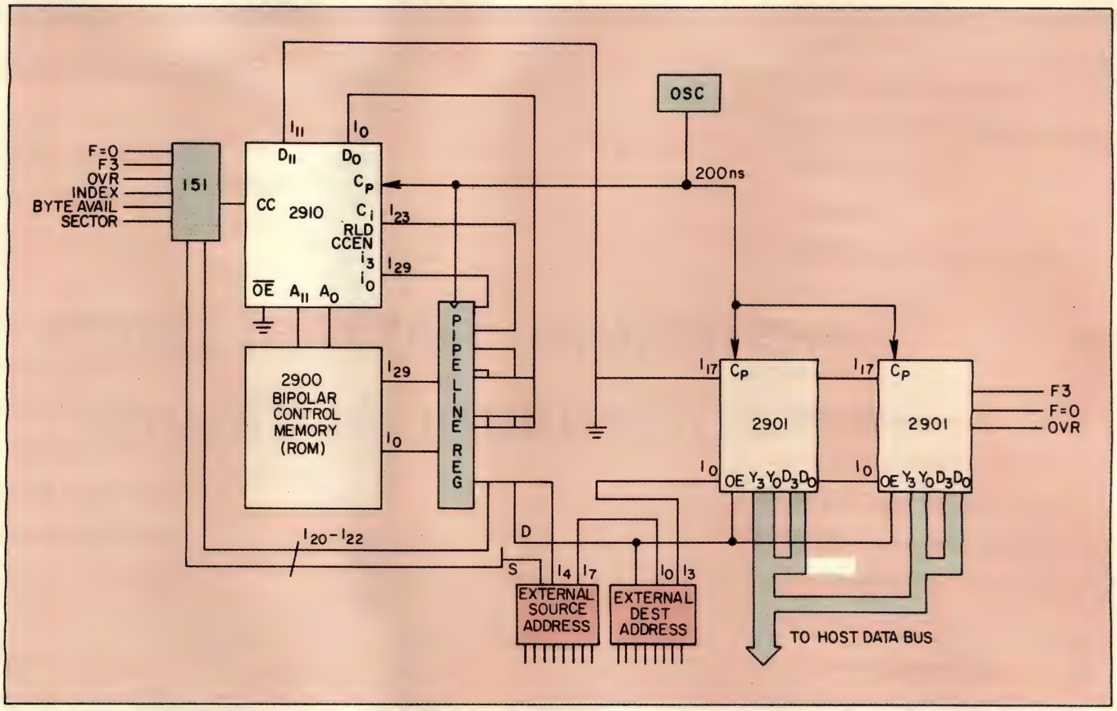
The slower, general-purpose NMOS chips are better known and, for certain applications, are more economical ($5 to $7 per chip) than the 2900 μP. They also constitute a more powerful and flexible design because more program space is available to implement complex commands.

A third alternative is offered by an 8 × 300 bipolar microprocessor, which operates at 250 ns per instruction. The 8 × 300 is currently a single-source microprocessor. As shown in Fig. 3, the 8 × 300 depends on just a few chips, rather than a sequencer, to keep up with the data rate. Because it is bipolar with some powerful bit manipulation capabilities, the 8 × 300 falls between the bit-slice and the NMOS approaches in flexibility and power.

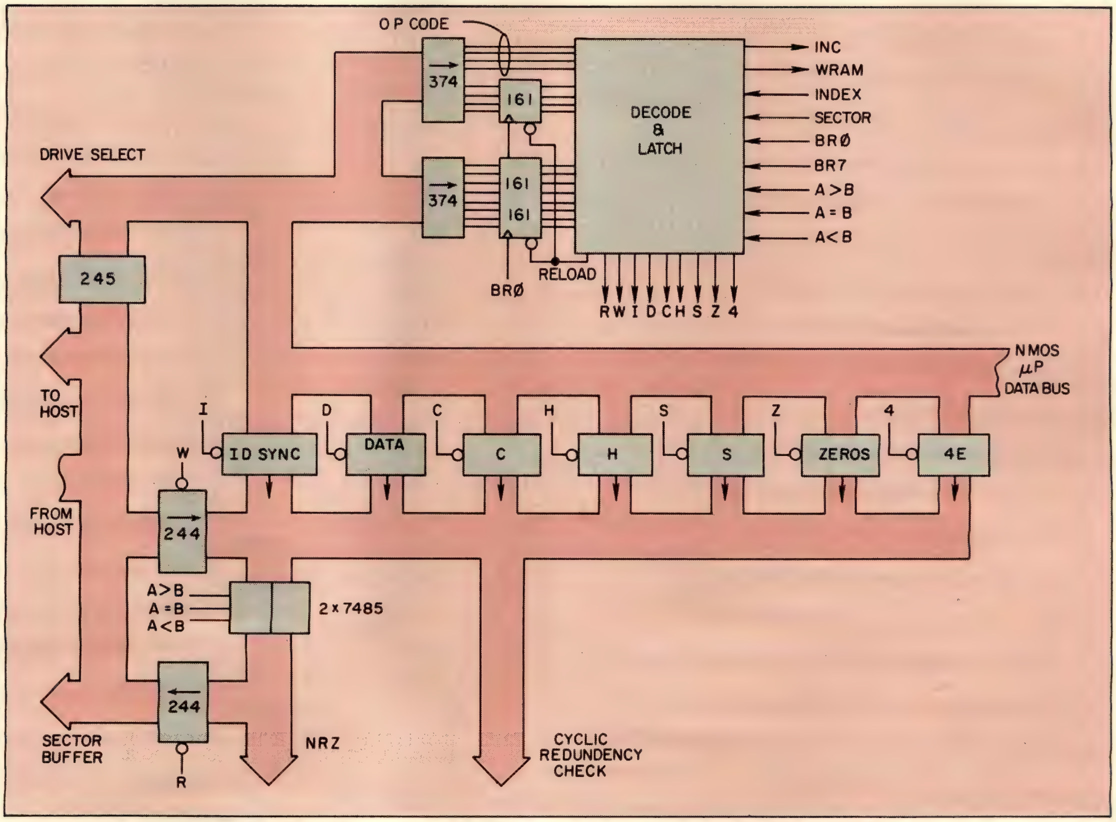
Laying out the track format

The system designer must next establish the track format layout by identifying data separator requirements for lock-on, choosing a synchronizing character for either an ID field or a data field and determining how many and what size sectors to incorporate on the disk.

Bernie Neiman, Engineering Manager
Shugart Associates
435 Oakmead Pkwy., Sunnyvale, CA 94086



1. The 8-bit architecture of a bipolar controller requires two processors plus a program sequencer. The two processor chips yield 25 bits and (with external REG control and a BRANCH code) a word length of 28 bits.



2. An NMOS controller allows more program space for implementing complex commands. Although this approach involves a slower processor, the support logic for the program sequencer makes the NMOS controller a good choice.

The ID field is separate from the data field. It should contain information on cylinder heads, cyclic redundancy checks and sector bytes.

Designers of controllers for floppy disk drives expect to incorporate a cyclical redundancy check (CRC) in the controller. CRC is an option for the Winchester disk drive. The soft error rate for the SA4000, for example, is one in 10^{10}. With a single retry, that data error can be eliminated. If the design can tolerate a retry every one in 10^{10} operations, then CRC is justified.

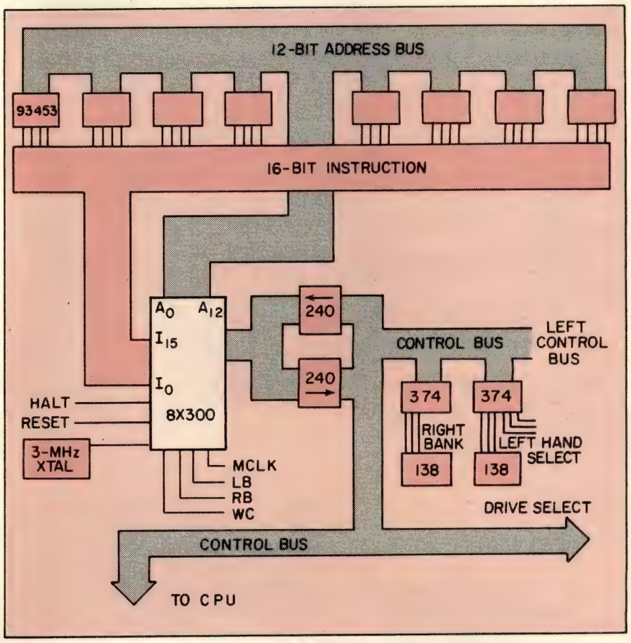
In the controller, the ID field will always be read before an update write operation, to verify the sector location. Since the SA4000 plugs jumpers on the drive, its 18,000-byte track can be divided into any number of sectors. Sector size and number are completely programmable, so the designer can optimize storage overhead on the drive.

The design of a track format must reflect the time the read amplifier needs to recover from a write operation. For the SA4000, this period is 20 μs, or about 18 bytes. When sequential sectors are to be written, the recovery time ends up in the track format—an inefficient use of disk capacity. Preferably, sectors should be interleaved to eliminate the time delay problem and the need for space on the disk (Fig. 4).

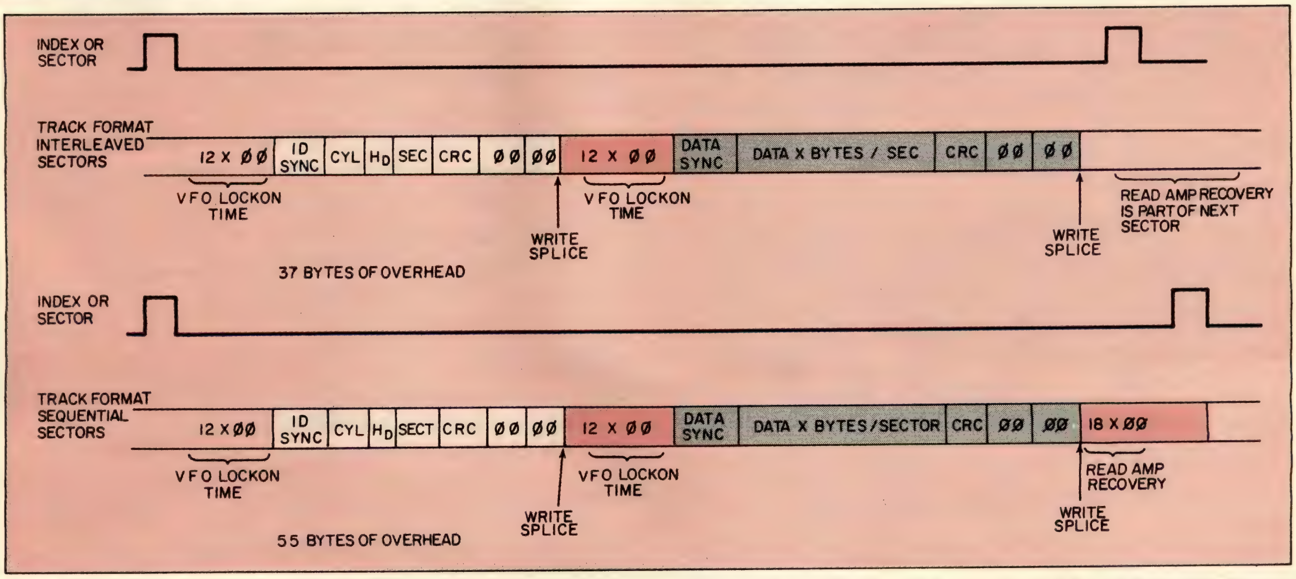
A Winchester disk drive must also have direct memory access to the CPU. But a general-purpose interface for a Winchester controller and a host CPU does not exist. Each CPU/disk combination has its own interface requirements, and so does each application.

Primarily, the design engineer must determine the minimum DMA cycle time for the speed at which the disk supplies data—in the case of the SA4000, 1.12 μs/byte. If the nominal data rate of the DMA logic is greater than the disk rate, the designer can incorporate a 1 or 2-byte buffer register to provide leeway for data overrun protection. For the SA4000 disk drive, the DMA channel should operate at greater than 889 kbytes/s. If a 32 × 4-bit FIFO is supplied, a request is made to the CPU to transfer data asynchronously from the disk input to the FIFO.

When the DMA logic cannot operate at the transfer rate of the disk, a full-sector buffer will eliminate the overrun problem. But the buffer costs from $30



3. Fewer chip requirements make the 8 × 300 processor a likely candidate for controller design. The data rate and the addition of hardware sequencers are not major concerns with this approach.



4. Interleaved sectors can eliminate time delay problems and leave more space on the disk for other functions (top). Sequential sectors make inefficient use of the disk capacity, since it includes time delays for recovery (bottom).

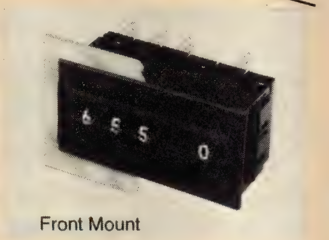
Announcing a tiny breakthrough.

We've made our line bigger to give you smaller thumbwheels.

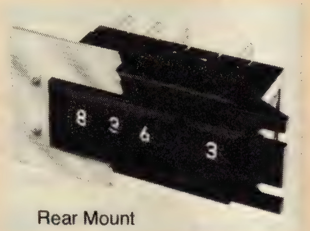
INCLUDING EXCLUSIVE SNAP-IN FRONT MOUNT

Presenting the smallest thumbwheels around: our new space-saving subminiature Series S2D, reduced to only .709" high matched with their standard .315" width. They're not just small. They're versatile... and easy to assemble. The things you can do with them:

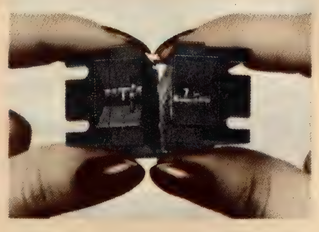
- Use less panel space to perform required functions.
- Mount them from either the front or the rear – just change the end mounting plates, that's all. No lefts, no rights.
- Snap 'em together! No hardware needed to assemble multiple decks. Just by snapping the end plates, blank bodies, dividers and switch bodies together, you can customize to your own needs.
- Available with the 9 most widely-used output codes as standard (other codes on request). S2D switches come with a wide range of options, including extended PC boards for mounting components, and right angle terminations.



Front Mount



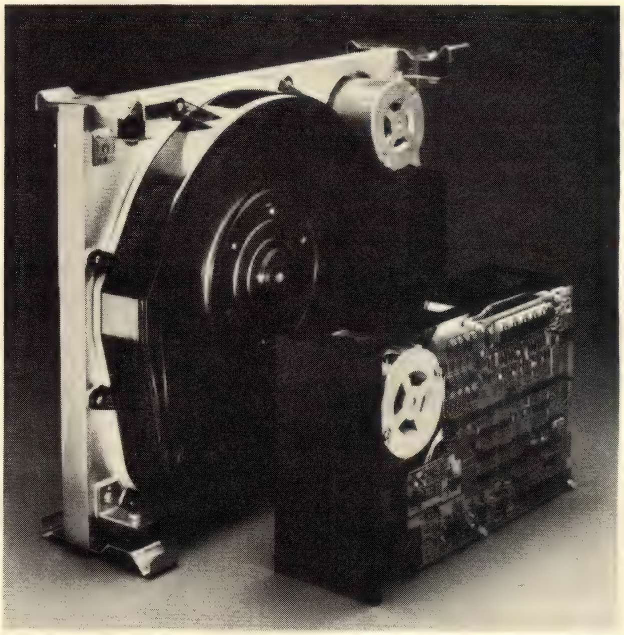
Rear Mount



For catalog and prices, call or write: Unimax Switch Corp, Wallingford, CT 06492; (203) 269-8701.

Unimax Switch®

CIRCLE NO. 63



5. Controllers for 14-in. fixed-disk drives, like the one shown above, cost less per byte than those for 8-in. disks. LSI chips play a significant role in cutting controller cost.

to $60 in MOS chips: two 2114 integrated circuits (1 k × 4 chips), an address select register and other support logic.

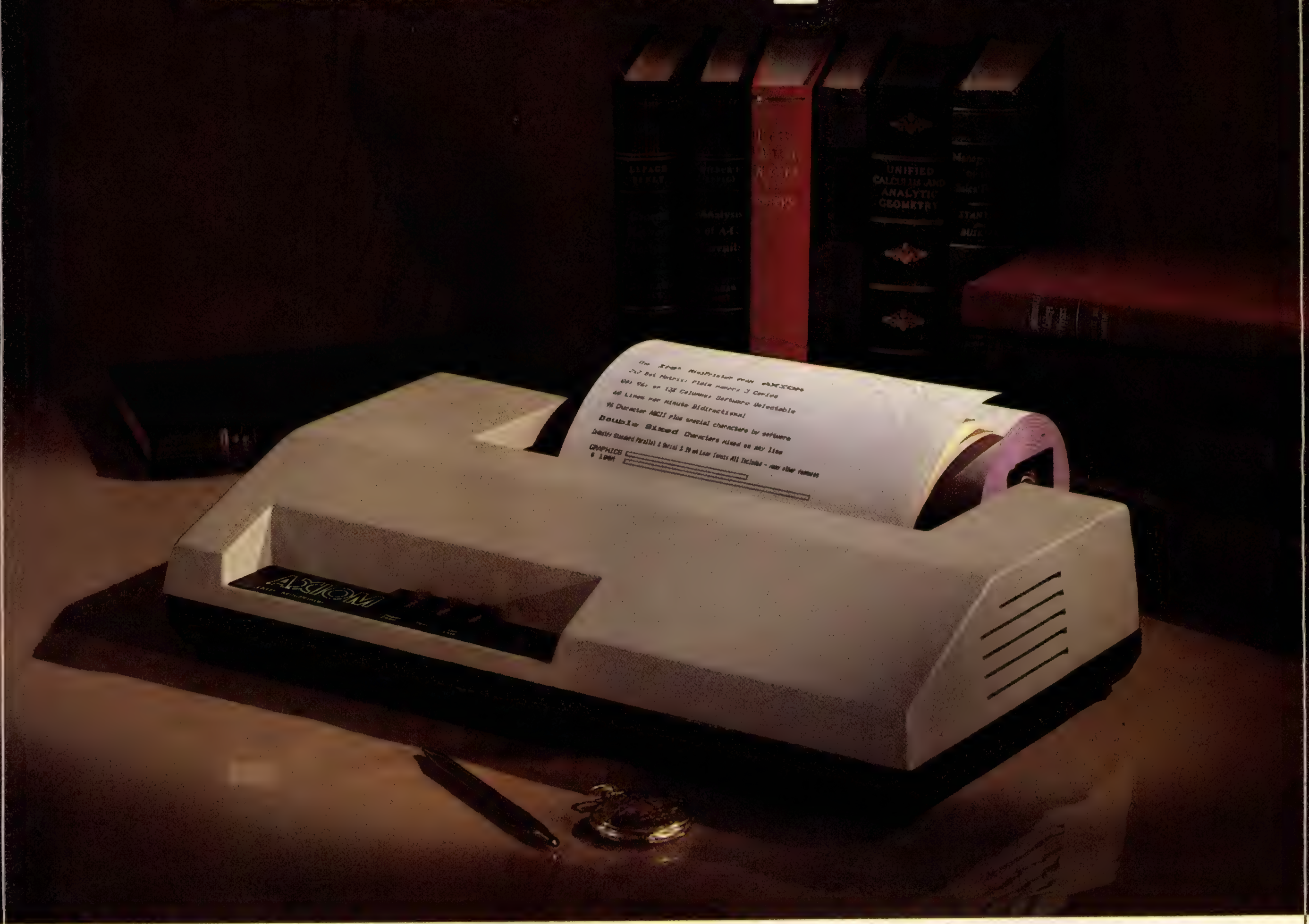
To offset its cost, the full-sector buffer relieves the host μP of several tasks. It verifies data before transfer to the host processor, so that only good data are transferred. It handles compare operations and copy operations off-line. Within the buffer, data sectors from one track can be copied to another or sectors can be reassembled and merged without being transferred to the host.

Every disk controller must include seek, format, read and write commands. After those are implemented in the disk controller and *if room* remains in the allotted microcode memory, the design engineer can consider more advanced commands: retries, a command to copy from one sector to another, search commands or imbedded seeks. If a seek can be imbedded into the read/write commands, a separate seek command is not necessary.

With attention to the data-rate problem, the controller design is resolved, and the low-cost Winchester drive can be incorporated in computer systems. The drive can be used with one or more floppies that provide backup storage, removable media and program loading capability.□

How useful?	Circle No.
Immediate design application	547
Within the next year	548
Not applicable	549

Little Impact.



Meet the IMPs. A pair of stylish 3½ inch high impact printers that will look great on any desk.

Styled for desk top use, these sleek units stand just 3½ inches high, yet the unique fan-cooled printing system can knock out 80, 96 or 132 columns of crisp hardcopy with continuous throughput of one line per second.

A winning pair. IMP-1, with friction feed, can make multi-copies on plain 8½ inch wide paper, or on teletype rolls. In addition, IMP-2 has tractor feed and full forms control, with tractors adjustable from 1 inch to 9½ inches.

Interfaces abound. All IMPs have Centronics parallel and RS232C/20mA serial inputs as standard equipment. But if you need something different, then we make interfaces for just about any system — high speed serial, Apple, Pet, TRS-80, IEEE 488...

Versatile, too. 96 ASCII character set is standard. And you can select 6 character sizes, even graphics, under software control. Options include 2K buffering and special character sets.

Service — a big difference. No other printer manufacturer offers Axiom's combination of low cost and nation-wide service and distribution — in the USA and eighteen overseas countries.

Pssst — the price!!! It's low. $695 for IMP-1. $795 for IMP-2. And that's the single unit price.

Better phone, write or mail the bingo card today!

AXIOM
AXIOM CORPORATION

5932 San Fernando Road, Glendale, CA 91202
Tel: (213) 245-9244 • TWX: 910-497-2283

CIRCLE NO. 64

HP announces a way to accelerate microcomputer development…

Design Production Service

HP—When you depend on logic

and have a little fun while you're at it.

At last, there's a universal development system that frees you from mundane development tasks and lets you concentrate on challenging software and hardware problems . . . HP's 64000 Logic Development System. It brings minicomputer programming features to microcomputer development for faster, easier and more enjoyable software development, hardware emulation and system analysis. And because it's a universal system, you can use it with today's most popular microprocessors.

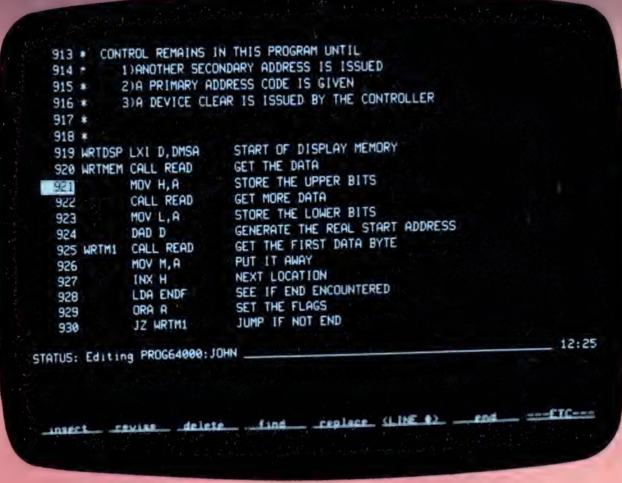
✓ - MICROPROCESSORS NOW SUPPORTED BY HP's 64000

Microprocessor	Full Support*	Macro Assembler Support	Microprocessor	Full Support*	Macro Assembler Support
1802		✓	8085	✓	
6800	✓		9900/9940/9980		✓
6801/6802		✓	F8/3870		✓
6805		✓	Z80	✓	
6809		✓	8086		
8021		✓	68000		
8022		✓	Z8000		
8035/8039		✓			
8041/8741		✓			
8048/8748		✓			
8049		✓			
8080	✓				

*Includes macro assemblers, linkers, emulation and analysis.

Put your fingers on a "soft key"

One of the system's key features is its ability to help you make decisions. At power up, for example, soft keys (keys whose functions are defined by CRT labels) give you a choice of 17 development functions, including edit, compile, assemble, link, emulate, PROM program and more. Pressing the edit key and typing in the name of a previously stored file result in a program listing and soft-key choices that simplify program editing, (shown above right). The CRT even flashes momentary directed-syntax messages to guide you in proper command entry.



```
 *  CONTROL REMAINS IN THIS PROGRAM UNTIL
 *     1)ANOTHER SECONDARY ADDRESS IS ISSUED
 *     2)A PRIMARY ADDRESS CODE IS GIVEN
 *     3)A DEVICE CLEAR IS ISSUED BY THE CONTROLLER
 *
 *
WRTDSP LXI D,DMSA      START OF DISPLAY MEMORY
WRTMEM CALL READ       GET THE DATA
       MOV H,A         STORE THE UPPER BITS
       CALL READ       GET MORE DATA
       MOV L,A         STORE THE LOWER BITS
       DAD D           GENERATE THE REAL START ADDRESS
WRTM1  CALL READ       GET THE FIRST DATA BYTE
       MOV M,A         PUT IT AWAY
       INX H           NEXT LOCATION
       LDA ENDF        SEE IF END ENCOUNTERED
       ORA A           SET THE FLAGS
       JZ WRTM1        JUMP IF NOT END

STATUS: Editing PROG64000:JOHN ______________________________ 12:25
```

The combination of minicomputer power and directed syntax using soft keys means you spend less time memorizing syntax, referring to instruction manuals, doing routine searching and entering line-by-line program changes. The 64000 handles most of those routine tasks so you can concentrate on the real problems. And that's true in assembling, linking, emulating and other development modes as well.

Work with a friend . . . or five

With HP's 64000, serial development is a thing of the past. Now, up to six team members can do software development and/or real-time emulation simultaneously. And each has immediate access to the latest version of software. That's because the 64000 has a hard disc that provides a common data base for all operators.

To assure accurate, real-time emulation, the 64000 has separate buses and memory for both the host and target processors. In addition, we use high-speed memory. As a result, there's no contention problem and your system runs at operating speed with no wait-states.

Of course there's much more to the 64000, including a wide choice of PROM programmers, up to 128K of emulation memory, an optional analyzer that gives you a real-time, transparent view of bus activity, and architecture powerful enough to adapt to future processor trends such as increased speed and bus width. Price for a minimum operating system is $18,500.*

Find out how much fun microcomputer development can be. For a copy of the HP 64000 brochure, write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

*Domestic U.S.A. price only.

080/7

HEWLETT
PACKARD

CIRCLE NO. 65

EW-8 $85.11*
EW-8-BF $92.90*
VIT-1 $15.00*

NEW ELECTRIC WIRE WRAPPING TOOL

O.K. Machine and Tool Corp. has introduced its new model EW-8 electric wire-wrapping tool. The tool is interchangeable with its previous model EW-7D, and incorporates a number of improvements at no increase in price. Rated to accept bits for wire sizes 22-30 AWG, model EW-8 features a reinforced Lexan™ housing, RFI reducing circuitry, and a high reliability motor and indexing mechanism. The tool is double insulated and weights only 14 ounces. Available with optional anti-overwrapping device as model EW-8-BF. Also available with accessory tool VIT-1 which permits easy resetting of indexing position in 45 degree increments.

Available ex-stock from

™ General Electric

OK Machine & Tool Corporation
3455 Conner St., Bronx, N.Y. 10475 U.S.A.
Tel. (212) 994-6600 Telex 125091

*Minimum billings $25.00, add shipping charge $2.00
New York State residents add applicable tax

A mainframe-communications protocol, when adapted to micro or minicomputers, cuts the overhead plaguing data transfers between CPU and peripheral disk units while increasing performance.

Big-system protocol boosts small-system performance

A communications protocol adds punch without much extra price to small micro and minicomputer systems by enabling them to perform sophisticated distributed data-processing functions at increased throughput. Called the Channel Command by Remex, the protocol is the basis of the Data Warehouse, an intelligent disk system that combines a 20-Mbyte Winchester disk with two floppy-disk drives. All three disks are controlled by a highly intelligent controller that implements the Channel Command techniques (for more on the system, see "Inside the Data Warehouse").

The Remex protocol brings today's compact intelligence to a concept that was way ahead of its time. Conceived 20 years ago by IBM as a way of "talking" to a peripheral with minimal communications, the protocol performed functions according to command "blocks," each with its own address. After fetching the code block address from its interface unit, the peripheral, under DMA control, retrieved the block of data. Then it returned the necessary status commands, and finally led the task to completion, thus freeing the computer from constant monitoring and interrupts.

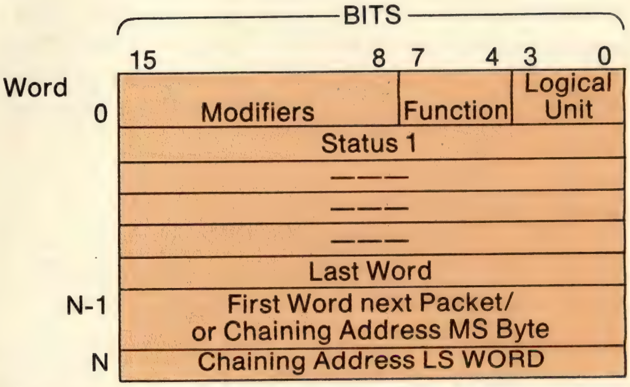
20 years too soon

However, the limited hardware available at the time made the idea too complex to implement; and while reducing CPU intervention, the hardware did not eliminate it.

What was needed was today's microprocessors and other LSI chips to control the DMA communications —advances that form the basis of Channel Command Control. Implemented fully and combined with the other capabilities of the Data Warehouse, the Channel Command far surpasses its IBM predecessor.

The protocol emerges just as disks are increasingly assuming the role of highly interactive storage subsystems, which effectively makes them extensions of main memory. The problem is, the I/O portions of current CPUs are not designed for this level of communications. In fact, such use of the disk often compels a computer to spend as much as 50% of its I/O activity on interrupts to and from the disk—time that could be used more effectively processing information. There are at least three possible solutions: a faster CPU bus, a faster disk drive, and the reduction or the elimination of programmed I/O-command transfers.

A faster CPU bus, which could be called the PDP-11/70-type solution, only partly solves the problem. While throughput could rise by 4 to 6%, it would still be up to the software to handle the interrupts for command generation.



1. The basic Channel Command format uses a set of command packets comprising 16-bit words. The packet, depending on the particular command, can range from three to ten words long. In word 0, the lowest-order bits designate the logical unit (Winchester, floppy No. 1 or No. 2) to be involved; bits 4 through 7 indicate the type of operation (read, write, copy, etc.); and the upper eight bits are used for performance-expanding modifiers. Subsequent words show how the operations are to be performed.

Tom Mitchell, Senior Product Specialist
Ex-Cell-O Corp., Remex Div.
1733 Alton St., Irvine, CA 92714

A faster disk drive has been tried in such units as 3330 and 3340-type drives, but at this point upgrading disk speed further would be superfluous: Many CPUs cannot even take full advantage of the existing disk-transfer rates.

The Copy packet (Fig. 2) is an important feature of the system: It provides for off-line copy either from the Winchester to a floppy, from a floppy to the Winchester, or between floppies with no host intervention. The drive not involved in the operation continues in an on-line interactive mode with the host. Automatic formatting is accomplished by the format packet in 128, 256, 512 or 1024-byte sectors.

Step-by-step

In general, a data transfer using Channel Command packets and interrupt control operates as follows:

Step 1. The computer outputs a memory address via programmed I/O on the data bus and generates an interrupt to the disk subsystem, which accepts the address. The controller can queue up to eight such addresses, even during data transfers. This minimizes bus contention and reduces software overhead.

Step 2. The controller goes to that memory address via the CPU's DMA facility. There, a series of program packets begins.

Step 3. The system transfers the first packet into the controller.

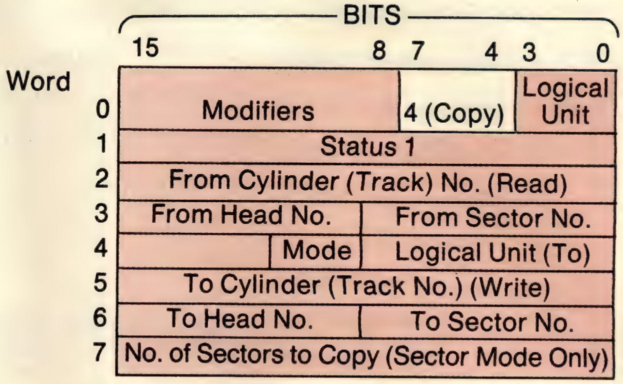
Step 4. If the packet is accepted, the system loads the packet's status word with zeros. The controller then interprets the parameters of the packet and executes a series of control, status and data transactions between the intended device and CPU memory. This is all performed through DMA. If the packet is rejected, the status word is loaded with the appropriate error code, an interrupt is set (if requested in the packet) and the starting memory address of the packet is sent to the CPU for interrogation.

Step 5. Once the packet is completed, the controller fills the status word with the status of that operation and interrupts the CPU (if requested in the packet) with the starting memory address of that packet for interrogation by the CPU (Fig. 5).

Only two I/O interactions

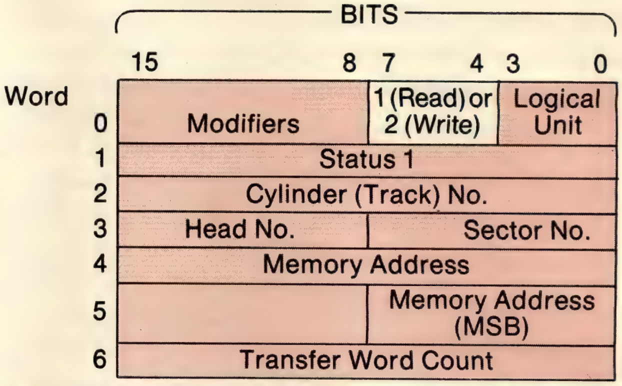
Note that, with Channel Command, only two programmed I/O interactions between the host and the Data Warehouse are required to complete this transaction; without Channel Command, five to ten would typically be required.

Performance can be improved and further tailored to the application by means of the modifiers (bits 8 through 15) in word 0 of the command packet.



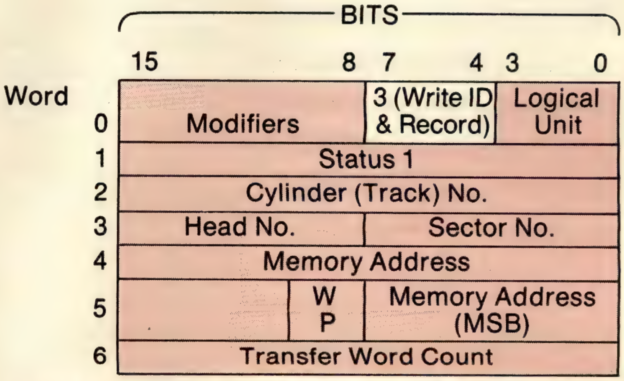
Word	BITS 15–8	7–4	3–0
0	Modifiers	4 (Copy)	Logical Unit
1	Status 1		
2	From Cylinder (Track) No. (Read)		
3	From Head No.	From Sector No.	
4	Mode	Logical Unit (To)	
5	To Cylinder (Track No.) (Write)		
6	To Head No.	To Sector No.	
7	No. of Sectors to Copy (Sector Mode Only)		

2. For copying data from one disk to another, the Command packet uses eight words. Two mode bits in word 4 indicate either copy by sector or copy to end of pack.



Word	BITS 15–8	7–4	3–0
0	Modifiers	1 (Read) or 2 (Write)	Logical Unit
1	Status 1		
2	Cylinder (Track) No.		
3	Head No.	Sector No.	
4	Memory Address		
5		Memory Address (MSB)	
6	Transfer Word Count		

3. Read or write data operations are set up in word 0 with bits 4 through 7. Other words in the packet indicate location on the disk. If the transfer word count is zero, the unit will seek only.



Word	BITS 15–8	7–4	3–0
0	Modifiers	3 (Write ID & Record)	Logical Unit
1	Status 1		
2	Cylinder (Track) No.		
3	Head No.	Sector No.	
4	Memory Address		
5	W P	Memory Address (MSB)	
6	Transfer Word Count		

4. For a Write ID and Record operation, one bit is used in word 5 as a write-protection-bit flag in the ID field.

For example, the user may increase throughput by setting up packet chaining. When the modifier is set for chaining in contiguous memory, the operation will not end at a packet's end, but will continue to read/write a specified additional number of packets or to the end of the memory. In noncontiguous chaining, the word following a packet is the memory address of the next packet. The Data Warehouse reads the address, goes to that place in memory, and continues the operation with no additional commands. The user thus can set up an entire day's job in a packet chain, issue one command, and, except for halts on errors, the system will run without supervision.

Reducing or eliminating programmed I/O-command transfers looks like the best solution. The strain placed on the programmed I/O by the disk can be significantly reduced by using that channel only to generate a start operation and to receive an interrupt when the operation is completed.

Such reduced programmed-I/O communications between CPU and disk are made possible by the DMA channel. The Channel Command is characterized by the type of DMA control, which varies depending on the type of CPU.

Combining DMA channel communications with contemporary μP technology not only reduces interrupts, it also allows much more data to be transferred per command. As a result, the systems engineer can:

- Generate a larger system with minimal upgrading the CPU
- Add more users to the system without degrading performance
- Store more data with the same system
- Work with a less expensive, slower CPU.

Packets cut interrupts

To reduce the number of interrupts, Channel Command uses command packets, or macroinstructions (Fig. 1), which are created in CPU memory by the device driver whenever data are required from or to the disk. These packets contain the traditional parameters for specifying the track, cylinder, head and sector information to be transferred. Up to 64 kwords of data can be transferred by a single command packet.

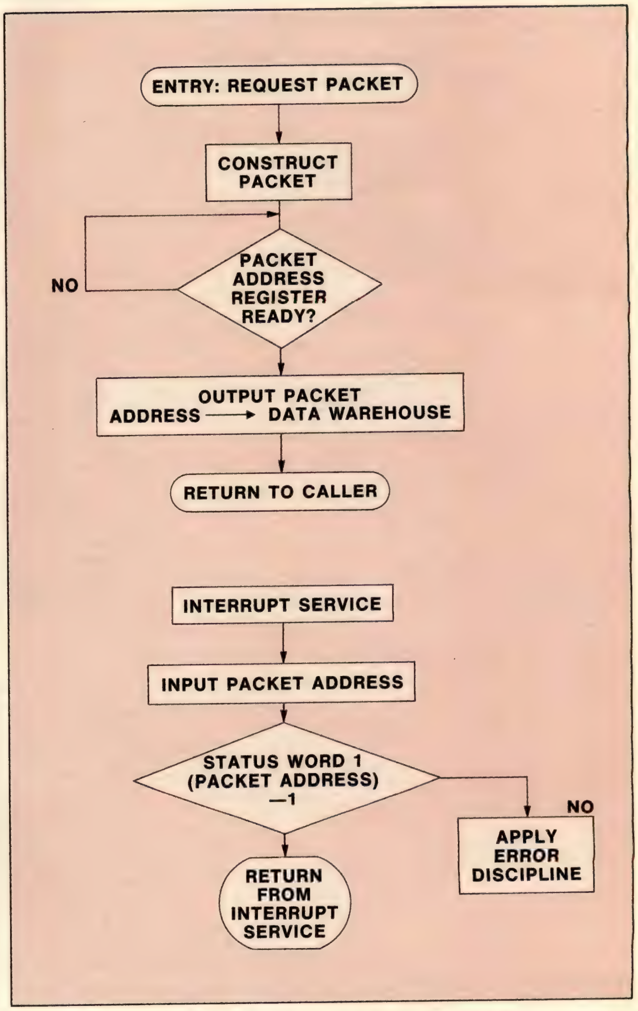
The upper byte, bits 8 through 15, of word 0 delineates eight modifiers—one per bit—that are performance-expanding "exceptions" to the standard operation of all routines. Bits 4 through 7 indicate one of four possible functions of the packet—read, write, format, copy. Bits 0 through 3 indicate the logical unit to which that format is to be applied—the Winchester, floppy No. 1 or floppy No. 2.

Status (word 1) indicates acceptance or nonacceptance of this packet and completion or noncompletion of the packet and any error indicated. Words 2 through N show the parameters of the operation.

A typical packet (Fig. 2) shows a copy routine from one floppy to another. Words 2 through 7 show the amount of data to be copied from where to where. (Figs. 3 and 4 show other operations.)

Packets within the system include an initial program load that permits bootstrapping information to be loaded two different ways. A single control line, Initial Program Load (IPL), when brought low by means of software control or front-panel switch, automatically transfers data from track 0, sectors 1 and 2, to location 0 in main memory. This information can also be accessed by initiating Channel Command with a memory address of 0.

Another modifier allows the interrupts between the packets to be suppressed. This is particularly useful in a partitioned system that lacks a common interrupt routine. The modifier allows each partition to poll its own packet, thus saving the software


ENTRY: REQUEST PACKET
CONSTRUCT PACKET
NO
PACKET ADDRESS REGISTER READY?
OUTPUT PACKET ADDRESS ⟶ DATA WAREHOUSE
RETURN TO CALLER
INTERRUPT SERVICE
INPUT PACKET ADDRESS
STATUS WORD 1 (PACKET ADDRESS) —1
NO
APPLY ERROR DISCIPLINE
RETURN FROM INTERRUPT SERVICE

5. When using the Data Warehouse, the central processing unit exercises concise routines to access data stored on the Winchester and floppy disks.

requirement of a common interrupt routine.

The modifiers help adapt operation even further to individual applications, by providing three ways to handle data errors. For example, when complete data integrity is essential, a full data-recovery routine internally implements automatic retries. However, an alternative is offered by a disable-correction modifier, which, when an error is detected, suppresses the data-recovery process and terminates the data transfer at the end of the bad sector. Status word 1 then indicates the error.

On the other hand, for optimum speed in data collection, a modifier bit (nonstop data transfer) can be set. Here, the error recovery process is suppressed and all data—including the error—are transferred until the command is completed. Again, the error is indicated in status word 1.

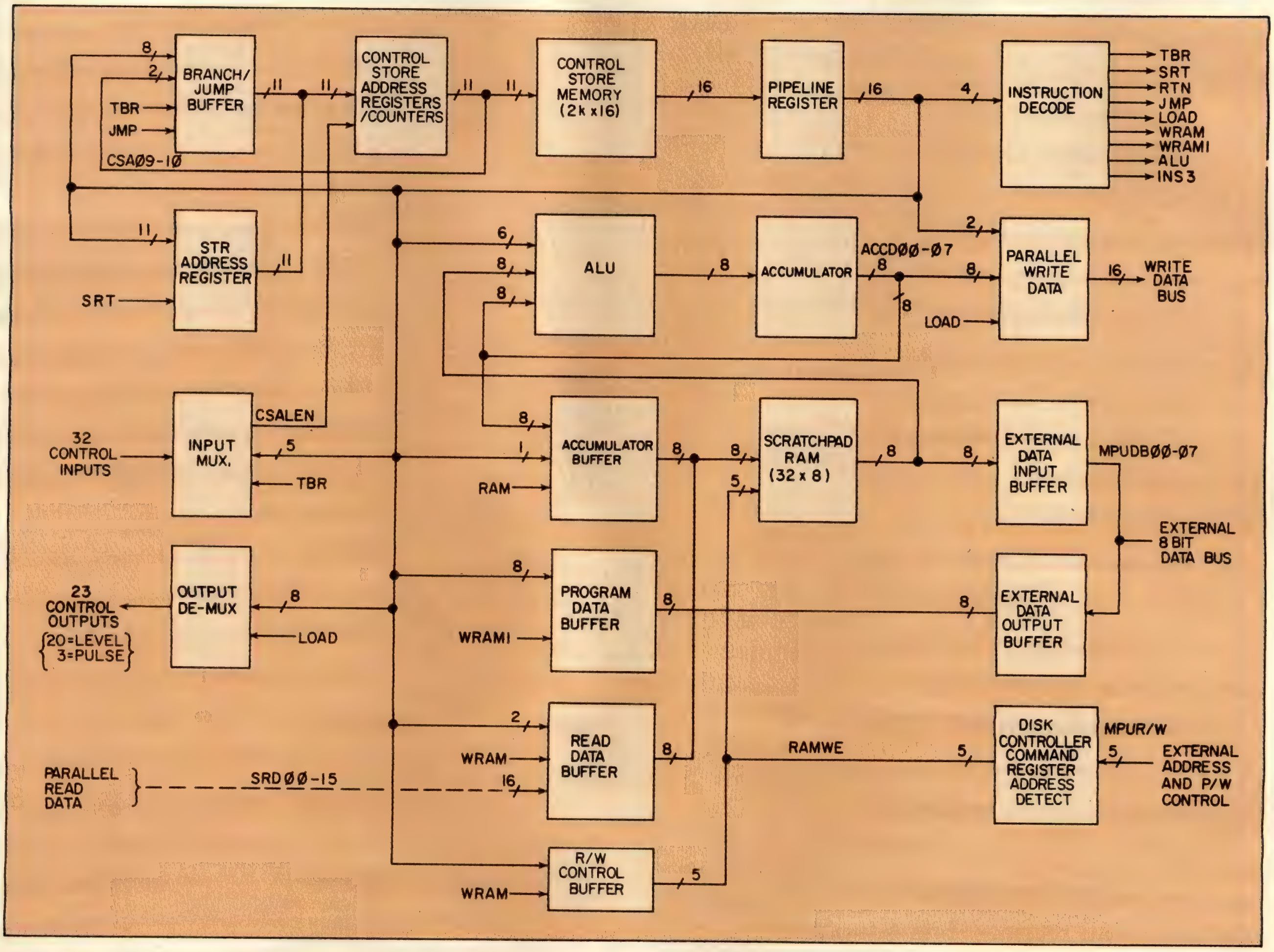
The system also provides for two levels of internal diagnostics. Level 1 handles automatic checks of the internal μP, ALU, data memory and program memory. The routine is initiated during power-up or after a master reset. Six LEDs on the controller card indicate types of errors under level 1. Level 2 is implemented under Maintenance-command packets.

Command performance

With a fully developed Channel Command protocol, the Data Warehouse system's on-board intelligence can be used not only to extend system throughput and flexibility but also to provide partitioned or multitask systems for distributed data processing. Here, the Data Warehouse offers two special capabilities: command priority and queuing.

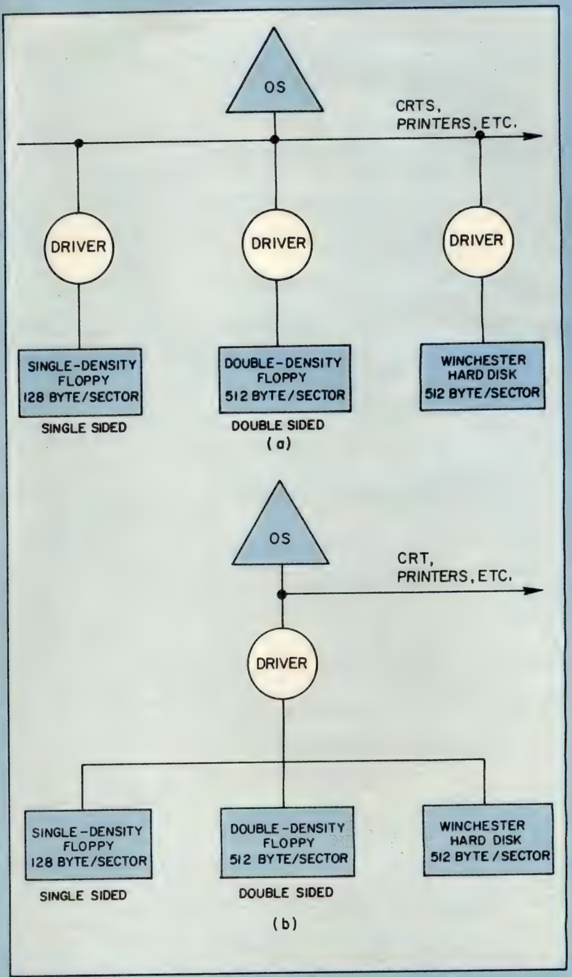
A command-priority system designates command packets as immediate, foreground and background. Immediate commands assume absolute control over the entire system, taking precedence over all other operations. They include the IPL packet and the Maintenance packets.

Foreground commands include the on-line system



6. The disk microcontroller uses hard-wired logic to achieve the circuit speed required to handle the 7.7-Mbit/s transfer rate of the Winchester disk. The speed also is needed to maintain a constant transfer in and out of the DMA buffer.

Inside the Data Warehouse


OS
CRTS,
PRINTERS, ETC.
DRIVER
DRIVER
DRIVER
SINGLE-DENSITY FLOPPY 128 BYTE/SECTOR
SINGLE SIDED
DOUBLE-DENSITY FLOPPY 512 BYTE/SECTOR
DOUBLE SIDED
WINCHESTER HARD DISK 512 BYTE/SECTOR
(a)
OS
CRT,
PRINTERS, ETC.
DRIVER
SINGLE-DENSITY FLOPPY 128 BYTE/SECTOR
SINGLE SIDED
DOUBLE-DENSITY FLOPPY 512 BYTE/SECTOR
DOUBLE SIDED
WINCHESTER HARD DISK 512 BYTE/SECTOR
(b)

As its name implies, the Data Warehouse high-performance disk system stocks plenty—in this case, storage and performance features. The 20-Mbyte Winchester disk and two single/double-density floppy-disk drives used by the Data Warehouse as logical units are in there for two reasons: They offer special capabilities and they work well together.

The Winchester is the principal storage medium because of its high speed, interactive mass storage, reliability and low cost per byte—an ideal combination for achieving a high-performance/low-cost ratio.

The two floppy drives, which may be single or dual-head, provide a standard I/O medium that is also simple, efficient and economical. And, for most applications, they can serve as convenient backup. Storage capacity goes up to 1 Mbyte per drive. Indeed, in an interactive mode, the floppy drives can be used interchangeably with the Winchester. Moreover, all three devices can be handled by a single controller with common read/write electronics.

Storage capabilities aside, the Data Warehouse —thanks to its on-board intelligence—is much easier to interface than other high-performance disk systems. Just one PI/O bus and one DMA bus are required. If ready-made interfaces are preferred, they are available for LSI-11, PDP-11 and Multibus, among others. And the interface can be located within the Data Warehouse or CPU.

Software drivers are available for RT-11 and CP/M 2.0. As the basic software diagram in the figure shows, a single driver may be used to control the three distinct I/O devices, thereby reducing software development.

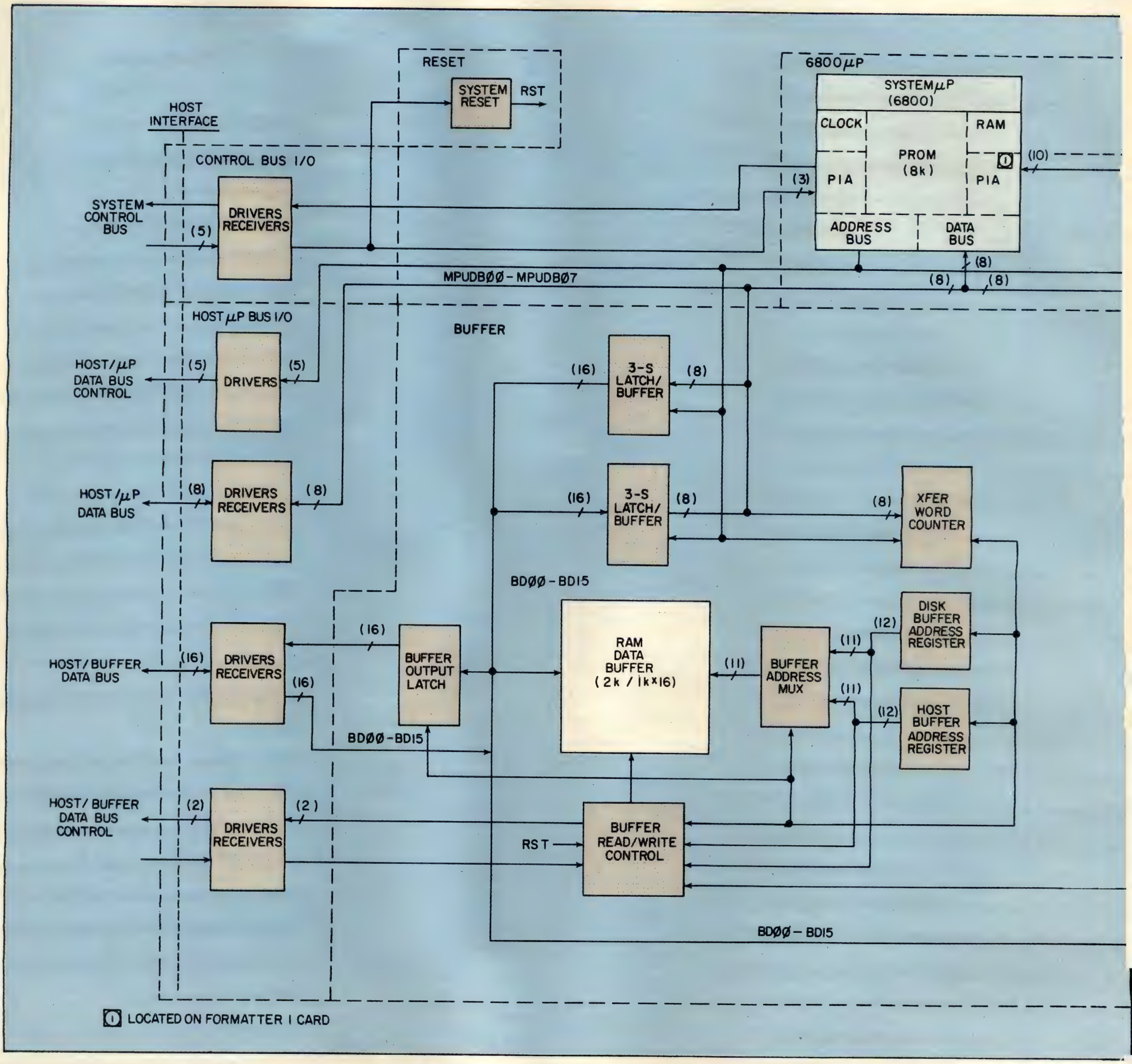
Other performance features of the Data Warehouse include:

- Automatic head/track advancing. This feature eliminates the need to send an address for each track and sector block, and does away with customer software requirements for tracking head/track selection.

- Automatic subsystem configuration. The three logical units of the system operate independently of each other in terms of sector size and density. Once a reset is issued to the Data Warehouse, the system will read each floppy as well as a set of switches for the Winchester to determine their sector sizes.

- Automatic sector sizing. The flexible disk units can be selected to read/write in single or double density and in 128, 256, 512 or 1024-byte sectors. Each on-line unit will automatically configure its own internal system to the sector size of the diskette loaded into the unit. Density is selectable by a switch on the controller.

- Automatic power sequencing. Under limited control, the Data Warehouse automatically sequences power to the flexible disk units to prevent excessive surge currents on startup.

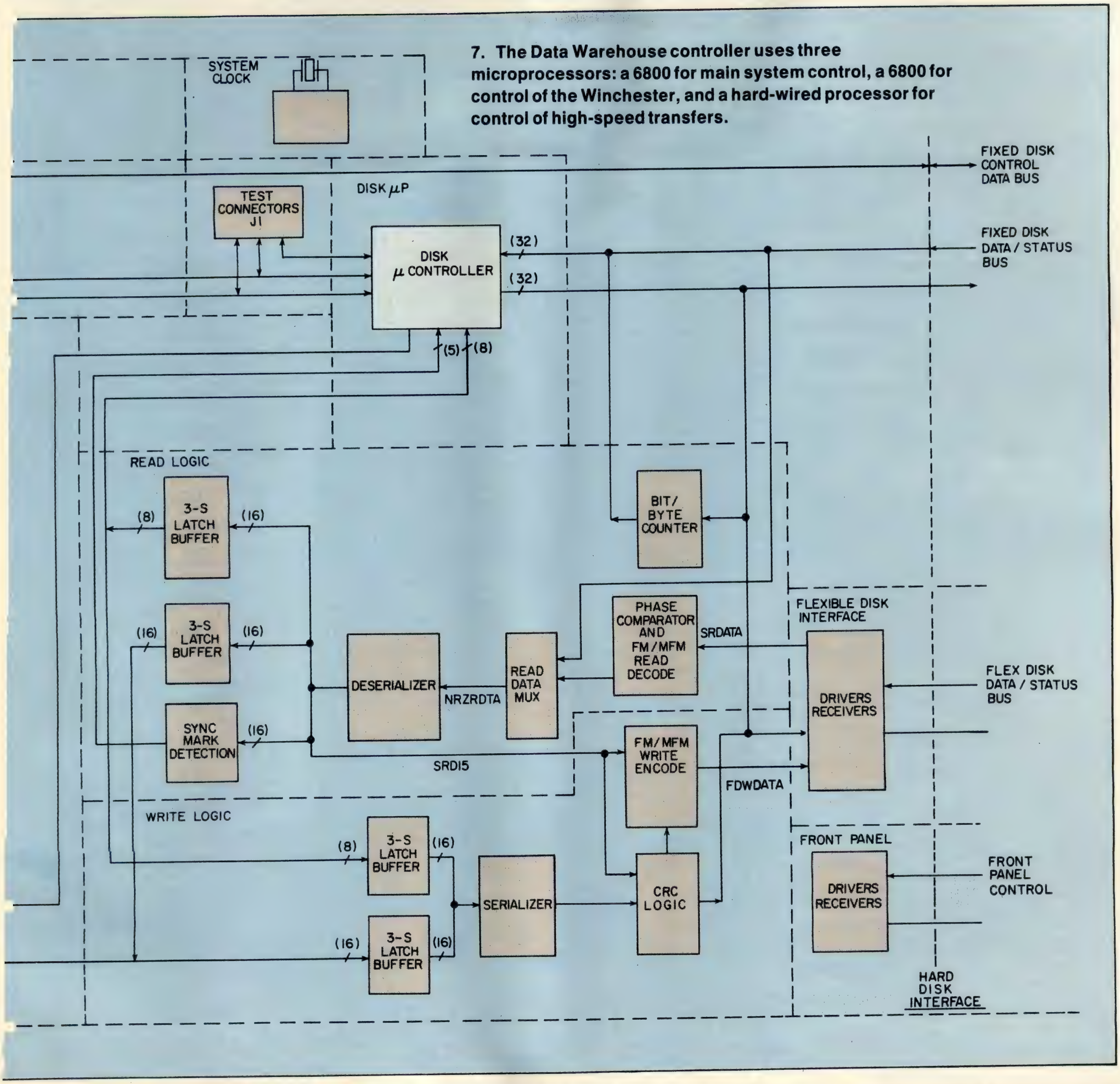


operations, such as Read and Write, which take precedence over the background commands; the latter include Copy and Format. Background commands, which proceed off-line, are suspended by the Data Warehouse once it receives the Read/Write and are automatically resumed when the foreground operations are completed. This interleaving capability allows more than one job to be carried on simultaneously as required for multitasking, and the background tasks free the host to perform other operations.

Queuing capability may be even more important. The Data Warehouse's system microprocessor will accept up to eight commands in a queue, with a ninth waiting on the interface. The commands are logged in and executed according to priority (i.e., foreground, background, immediate). Once one of the commands in the queue is processed, the system will allow the command on the interface into the queue and then it will accept another command on the interface.

When each job is completed, the Data Warehouse sends back the address of the packet, enabling the host to determine which user job has been completed. Obviously, the queuing feature will allow one user to perform eight different tasks simultaneously or will permit eight users to access the Data Warehouse at the same time.

The actual controller formatter (Fig. 6) is contained on two formatter cards and driven by three



7. The Data Warehouse controller uses three microprocessors: a 6800 for main system control, a 6800 for control of the Winchester, and a hard-wired processor for control of high-speed transfers.

on-board microprocessors: a 6800 to provide the main systems control, a 6800 devoted to controlling the Winchester drive and a hard-wired disk microcontroller that implements high-speed transfers and peripheral device control. The hard-wired disk microcontroller (Fig. 6) takes full advantage of the Winchester's 7.7-Mbit/s transfer rate and maintains a constant transfer in and out of the DMA first-in, first-out buffer. The controller's design (Fig. 7) is configured to provide "multiple-user" access to the DMA channel by the CPU, intelligent controller, disk microcontroller and read/write electronics.

All DMA transfers pass through the DMA FIFO buffer. Dynamic data buffering of up to 2 kwords allows a constant transfer rate under varying CPU conditions. What's more, without CPU intervention, the handshake controls help the buffer prevent loss of data due to overrun or underrun.

The controller, by providing for up to 24 bits of memory addressing, is easily adaptable to a variety of CPUs. The unit's "bus-mode select" feature allows the Data Warehouse to function equally well with an 8 or 16-bit processor. Selection is made by a jumper on the interface.□

How useful?	**Circle No.**
Immediate design application	550
Within the next year	551
Not applicable	552

First, imagine small. Because Statek Crystals are small . . . approximately 1/10 the size of conventional low frequency crystals. They employ the tuning fork crystal technology Statek introduced, then perfected for the watch industry. Thus, the small 68¢* cost . . . the lowest cost, high volume, crystals available for discrete or hybrid use . . . world-wide.

Next, they're accurate. Much more accurate than any LC or RC oscillator or frequency control network . . . today, next year or long-term. In fact, the 100x improved aging and accuracy of the CX series eliminates costly alignment and "zeroing-in". . . for a life-time.

And you won't have frequency selection problems either . . . 19 standard frequencies, plus Statek's precision laser tuning that lets you pick from over 350,000 others.

If you have an immediate volume application, contact the factory for samples or specific information. Or consult EEM/GOLD BOOK for specifications.

Statek Corporation, 512 N. Main, Orange, California 92668, Telephone: (714) 639-7810 TELEX 67-8394

*100k qty

STATEK

INNOVATORS IN FREQUENCY CONTROL

CIRCLE NO. 20

Beat Murphy's Law!

with Acromag analog signal conditioning modules

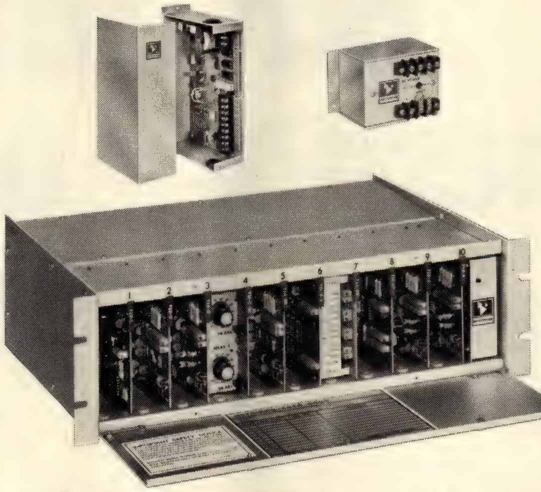
REAL WORLD ANALOG INPUTS

- 4–20 mA
- 3–15 psi
- 0–5 amps AC
- 10–50 mA
- 0–10 mV
- 0–150 volts AC
- Thermocouples
- 0–1000 watts
- Pulses
- Strain Gage Bridges
- RTD (Resistance Temperature Detector)
- Your Signal

REAL WORLD ANALOG OUTPUTS

- 4–20 mA
- 3–15 psi
- Pulses
- 10–50 mA

ACROMAG ANALOG SIGNAL CONDITIONING MODULES



- Modules accept real world analog inputs and output clean high level (single-ended) analog signals to any computer system. Features include:
- Built-in filtering to eliminate noise
- Ability to mix & match various input signals
- Lower software overhead (Linearize in hardware)
- Flexibility to permit redundant configurations
- Isolation to eliminate ground loops
- Diagnostic mode indicates thermocouple failure
- No external temperature reference required
- Rugged screw terminals for easy field wiring

YOUR COMPUTER SYSTEM

ANY HIGH LEVEL A/D

ANY CENTRAL PROCESSOR

ANY D/A

We can help your computer talk to the real world!

If Murphy had come to Acromag with his analog signal conditioning problems, he might not be famous today.

Acromag analog signal conditioning modules make real world signals computer-compatible and enable you to buy exactly what you need — no more, no less. Plus you can mix and match signal types as necessary.

We've been helping people solve many types of analog signal conditioning problems for more than 20 years in demanding process control applications.

Solving Murphy-like problems is one of our specialties. Call us to discuss your application needs today.

FREE! *"Murphy's Laws of Instrumentation"* Copies available upon request. If you'd like one, just bingo this ad. But act now while supply lasts!

acromag

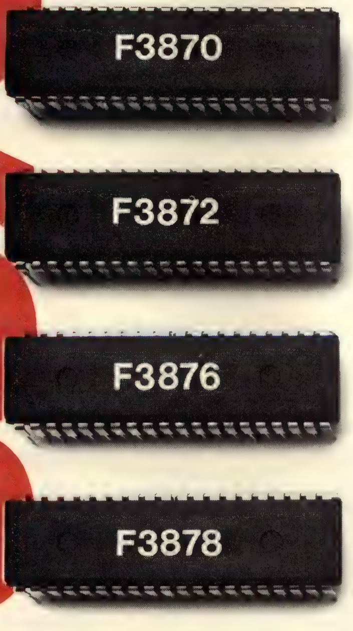
ACROMAG®

30765 Wixom Road • Wixom, Michigan 48096
Telephone 313/624-1541 • Telex 23/0505

CIRCLE NO. 68

F3870 SERIES

Now that our microcomputers have more memory options, so do you.



DEVICE	RAM	ROM	I/O
F3870	64 x 8	2K x 8	32
F3872	128 x 8	4K x 8	32
F3876	128 x 8	2K x 8	32
F3878	64 x 8	4K x 8	32

We've just expanded our industry-standard F3870 line by adding three new microcomputers with increased on-chip memory options. Each is a complete 8-bit microcomputer on a single MOS chip and is 3870 pin-compatible.

Bigger ROM memories.

The series begins with the multi-source 3870 that gives you up to 2K bytes of ROM. With our three increased-memory versions, you can now get more features, a more sophisticated controller and more design flexibility.

Starting with the F3876 which offers 2K ROM, and the F3872 and F3878 which offer 4K ROM. These give the designer the size versatility he needs for almost every application, as well as allowing him to make smarter controllers.

More RAM with power-down protection.

The F3872 and F3876 offer 128 bytes of RAM, with 64 bytes available for power-down protection. That means that if your system shuts down, there's no memory loss, because the RAM remains powered and protected, with low current demand.

A microcomputer for all reasons.

No matter what your application needs, the F3870 series can meet them. It's an excellent choice for a wide variety of control applications, including terminals, communications, automotive and instruments. It's the perfect family of low-cost microcomputer circuits for the high-volume, cost-sensitive controller market.

So now, there isn't a more complete family of devices available that will let you build a new system, or upgrade an existing one. For more information, contact your Fairchild office.

POWER DOWN	POWER SUPPLY
NO	5V
YES	5V
YES	5V
NO	5V

FAIRCHILD
A Schlumberger Company

France: Fairchild Camera & Instrument S.A., 121 Ave. d'Italie, 75013 Paris. Tel: 331 584 55 66. Telex: 0042 200614. **Italy:** Fairchild Semiconduttori S.P.A., Via Rosellini, 12, 20124 Milano. Tel: 02 6 88 74 51. Telex: 36522. **Germany:** Fairchild Camera & Instrument (Deutschland) GmbH, 8046 Garching Hockbruck, Daimlerstr. 15, Munchen. Tel: 089 320031. Telex: 52 4831 fair d. **England:** Fairchild Camera & Instrument (UK) Ltd., 230 High St., Potters Bar, Hertfordshire EN6 5BU. Tel: 0707 51111. Telex: 262835. **Sweden:** Fairchild Semiconductor AB, Svartengsgatan 6, S-11620 Stockholm. Tel: 8-449255. Telex: 17759.

CIRCLE NO. 170

NOW ZENITH GIVES YOU A BRAND NEW WAY TO MEASURE CRT DISPLAY QUALITY.

Now Zenith technology comes packed into a brand new CRT Display format. Introducing the D12-100. This new model in our expanding line has a diagonal measurement of 12 inches. But the story is much, much bigger.

THE D12-100

To deliver maximum performance at lower cost, our new D12-100 is designed with a 4x5 aspect ratio rather than the currently used 3x4 aspect ratio. In those applications where the D12-100 is appropriate, it offers all the reliability and dependability of our fully featured, top-of-the-line 3x4 aspect ratio models.

No wonder. The D12-100 is designed and tested to meet the same quality and reliability standards established for *all* Zenith CRT Displays. Thousands of test hours under extreme humidity, vibration, altitude and temperature conditions. And exhaustive analysis, including electron microscope and thermograph scans in the Zenith Reliability Lab.

APPLICATION ENGINEERING

The D12-100, like every Zenith CRT Display, can be designed to meet your own specifications, as well. We'll meet with you to determine your exact requirements. And then custom build a D12-100 to fit. Since the D12-100 is also the start of a new series of CRT Displays, we'll be happy to talk about other screen sizes as well.

ZENITH TRADITION

At Zenith, we're building CRT Displays with the same commitment to excellence that's made us number one in the television industry. When you want a product that works, with delivery on *your* time schedule, plus proven reliability and dependability... you want what we've been giving our customers for over 60 years.

More big ideas are coming. For further information and specifications, write: CRT Display Engineering Division, Zenith Radio Corporation, 1000 Milwaukee Avenue, Glenview, Illinois 60025, or call (312) 773-0074.

ZENITH®

The quality goes in before the name goes on.

National Computer Conference, May 19-22, Booth 3023-25.

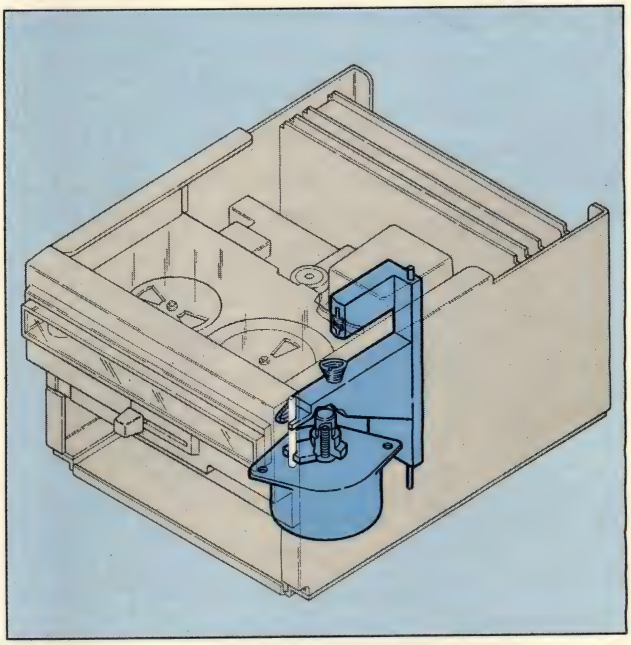
CIRCLE NO. 70

Winchester-disk backup should be low-cost, compact and reliable; all three come together in a high-capacity cartridge-drive.

Cartridge-drive system suits Winchester backup

A modular, microprocessor-based, 67-Mbyte data-cartridge drive combines with a formatted, high-capacity data cartridge to function as a removable, or backup, memory device for minicomputers and remote terminals. Moreover, with low cost, compactness and reliability added to its high capacity, this powerful combination looks like the ideal solution for Winchester-disk backup. The 4.6 × 7 × 19-in. system features a 17.5-kbyte/s transfer rate in the streaming mode (4 Mbytes/s maximum burst mode) and, along with a formatted capacity of 67 Mbytes, 144 Mbytes unformatted.

The DC-600HC cartridge is essentially a specialized, miniature, enclosed reel-to-reel system that works bidirectionally. The read/write head is a single-track proprietary design whose positionable, μP-controlled mechanical assembly uses the edge of the 1/4-in. tape for reference to permit precise positioning at one of the 16 tracks across the tape (Fig. 1).



1. The HCD-75 tape drive is mechanically assembled for precise positioning of the read/write heads. The microprocessor-controlled assembly uses the edge of the tape for reference.

The system's data format is prerecorded, which permits not only more efficient writing but also an error-correcting system. There are no conventional interrecord gaps (IRGs) to mark the starting point of each block; rather, a prerecorded block key marks the beginning of each 1024-byte block, regardless of the direction the tape moves. Consequently, space that would have been empty is used to record data.

Continuous diagnostics

While the system is operating, μP-controlled diagnostic routines run continuously, preparing sophisticated error messages when faults are detected. During all read operations, error detection/correction ensures low error rates. In addition, processor control of the drive mechanism eliminates all adjust-

---

Robert E. Wolff, Laboratory Manager
3M Co., Mincom Div.
St. Paul, MN 55133

ments: PC boards and modules in the system are completely interchangeable.

In a *typical* application, an LSI-11 microcomputer, all that is needed for a fully operable system interface is a standard, readily available DMA interface card. No personality or special boards are required. The DMA card will simultaneously handle DMA function and normal I/O under processor control.

Fig. 2 shows the interface between a host CPU and the tape drive, with two HCD 75-to-CPU signals and six CPU-to-HCD 75 signals detailed. Each controller/formatter module handles up to four data-cartridge drives, which operate according to controller commands implemented by the individual μP-controlled drive units. The command and status lines from the controller/formatter module to the drives are internal to the operation of the system.

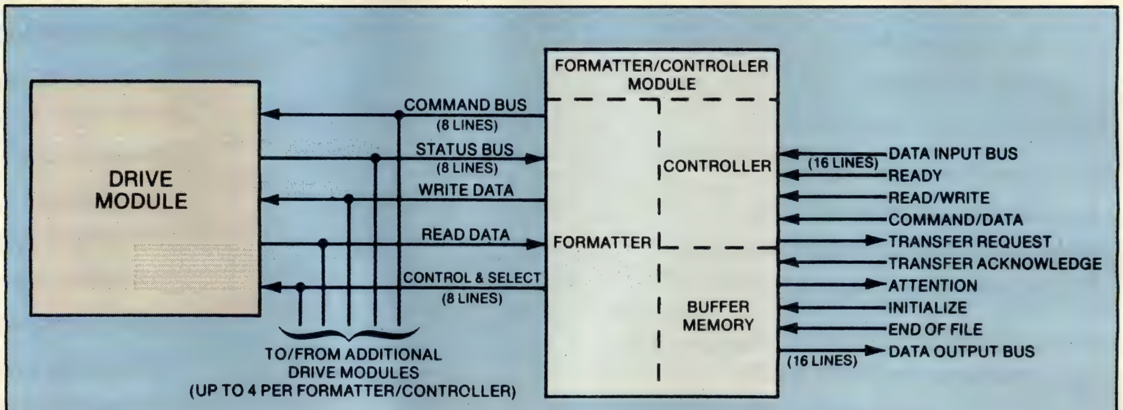
The data configuration between the controller/formatter module and the host CPU is a 16-bit parallel data transfer that is bidirectional, in response to specific commands illustrated. Only two transfer signals are transmitted from controller/formatter module to host: Transfer Request and Attention. The latter signal is activated should a fault occur that requires operator intervention.

With the tape drive under μP control, the beginning of tape (BOT) and end of tape (EOT) and block keys are represented by specific data patterns that can be recognized and distinguished by monitoring circuitry. As Fig. 3 shows, the BOT and EOT both have distinct data patterns. The stepper motor is also μP-controlled, and the initial head reference is derived from the edge of the tape. To control the motor, monitoring circuitry reads the data in the key blocks to detect the edge of the tape, which causes the stepping motor to move in precisely-spaced increments from the reference point.

Full I/O

Standard operation is fully buffered I/O, which permits the transfer of 16-bit asynchronous words on the data input and data-output buses (Fig. 2). The host processor initiates action and specifies the memory locations.

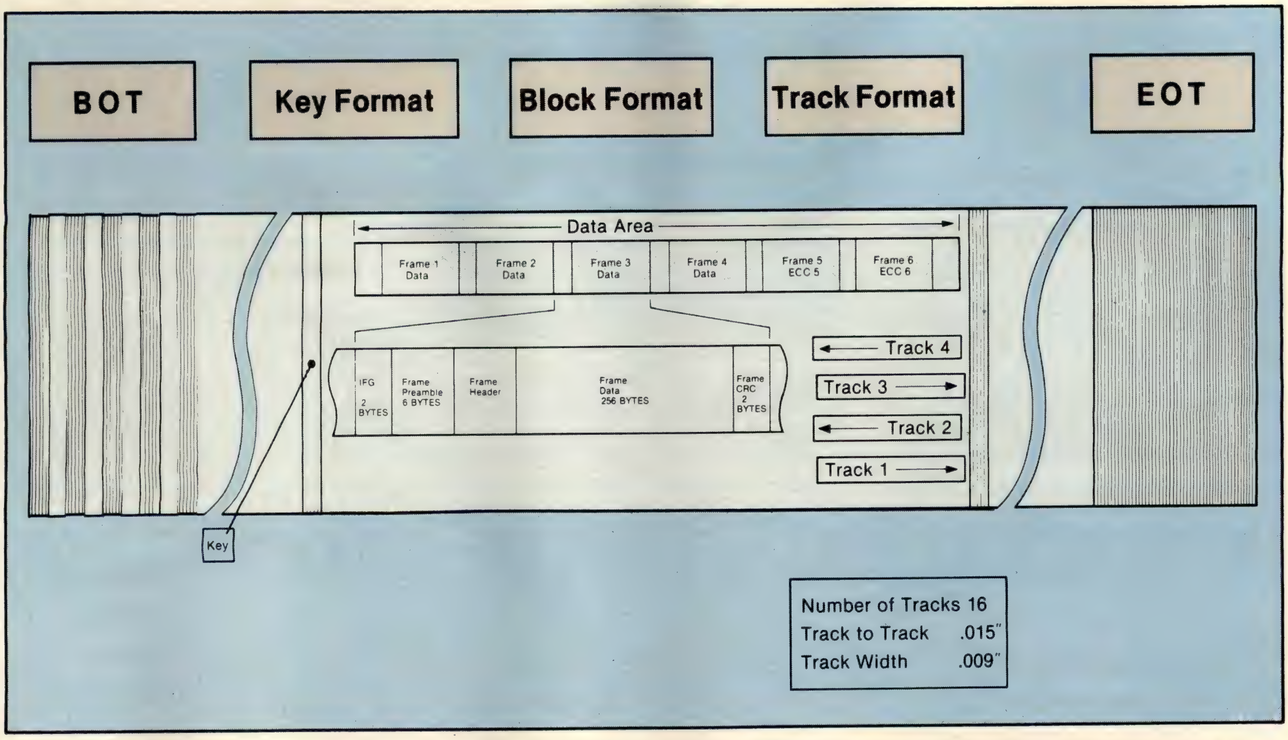
With the DMA interface card in place, direct data



HOST INTERFACE

Ready:	Set low to start a data transfer. Returned high to end transfer
Read/Write:	Set high to command write. Set low to command read.
Command/Data:	Set high to enter commands. Set low to enter data.
Transfer Request:	Set low to indicate that the drive is ready to accept a word of write data or that a valid word of read data is present on the output bus.
Transfer Acknowledge:	A high going pulse to indicate completion of a transfer by the host
Attention:	Set high to indicate fault, status change, or end of file for read mode.
Initialize:	A high going pulse or level to reset all interface logic
End of File:	Set high when the last block of a file is being transferred during write operations.

2. The interface between the CPU and the cartridge system allows a transfer rate of 4 Mbytes/s and an effective streaming rate of 17.5 kbytes/s.



3. The data-cartridge format details the fact that EOT and BOT are different sections at the ends of the tape. Sixteen tracks are recorded and read back in a serpentine fashion.

transfer from memory in the data-cartridge system to that in the host CPU is automatic. The starting address in each memory is specified and the number of bytes to be transferred is entered. The DMA and buffered I/O operations can occur simultaneously.

As Fig. 3 shows, the 16 tracks are recorded and read back in a serpentine fashion. The forward direction of the tape travel is indicated for odd-numbered tracks and backward for even-numbered tracks. Each track holds one block of 1024 8-bit bytes consisting of four 256-byte frames, with two additional frames used for error detection and correction between two adjacent keys.

A number of μP-controlled diagnostic routines are called into action at specific checkpoints. Whenever power is turned on, the system runs a memory check, in both the controller/formatter-module memory and the RAM.

When a cartridge is inserted, a format test assures that it is a DC-600HC and not a physically compatible but unformatted cartridge. Once the cartridge is inserted, a read-amplifier-gain test is run, as is a head-position test (in which the head seeks the edge of the tape, then traverses the entire width and returns to zero-out at its original position). All this time a servo-speed test is being run along with a test to check cartridge-drive power. The power test checks for any physical drag in the cartridge.

Errors are detected and corrected by writing an error-correction frame for every two data frames in the block. To generate frame 5 in Fig. 3, for example, equivalent bytes from data frames 1 and 3 are compared and a parity bit is created for each bit position. The same is done for data frames 2 and 4. Then, on readout, the data frames are checked for correct CRC codes.

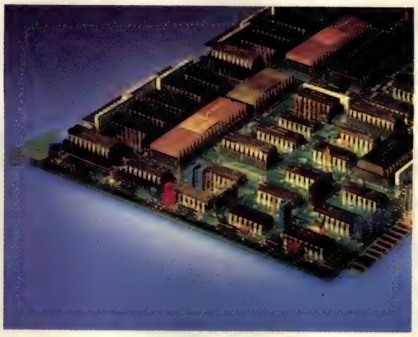
If an error is detected, the data frame is automatically reconstructed via the error-correction frame. Only a major unreconstructible error, such as one caused by physical damage to the tape, would be reported on the Attention line. Otherwise, users are generally unaware of errors because they are remedied internally.

Also internal is the μP routine for head-to-tape alignment. It takes 19 incremental steps to move from one track to the next, which actually enhances the accuracy of the process. Since the reference point is always at the edge of the tape, physical variations in cartridge dimensions are not relevant. This means that variations within physical tolerances could be far outside the tolerances necessary for accurate track alignment.

Besides looking like the right answer to Winchester users, the *HCD-75* system will prove suitable in a wide range of applications, including data interchange and program distribution.□

How useful?	**Circle No.**
Immediate design application	**553**
Within the next year	**554**
Not applicable	**555**

Expand with the MSC 8001



The MSC 8001 is a MULTIBUS™ compatible single board computer designed to provide new dimensions in function and versatility. Built around the powerful eight-bit Z80™ CPU, the MSC 8001 provides a flexible memory addressing scheme and extensive input/output capabilities at prices well below competing single board computer products. Using the MSC 8001 as a master module, you can select I/O and special feature modules to configure a system of virtually any complexity or refinement.

Expand SBC 80 systems Upgrade existing SBC 80 systems that are being slowed down by limited memory size or restricted execution cycles. All existing I/O boards and memory expansion cards will operate with the MSC 8001.

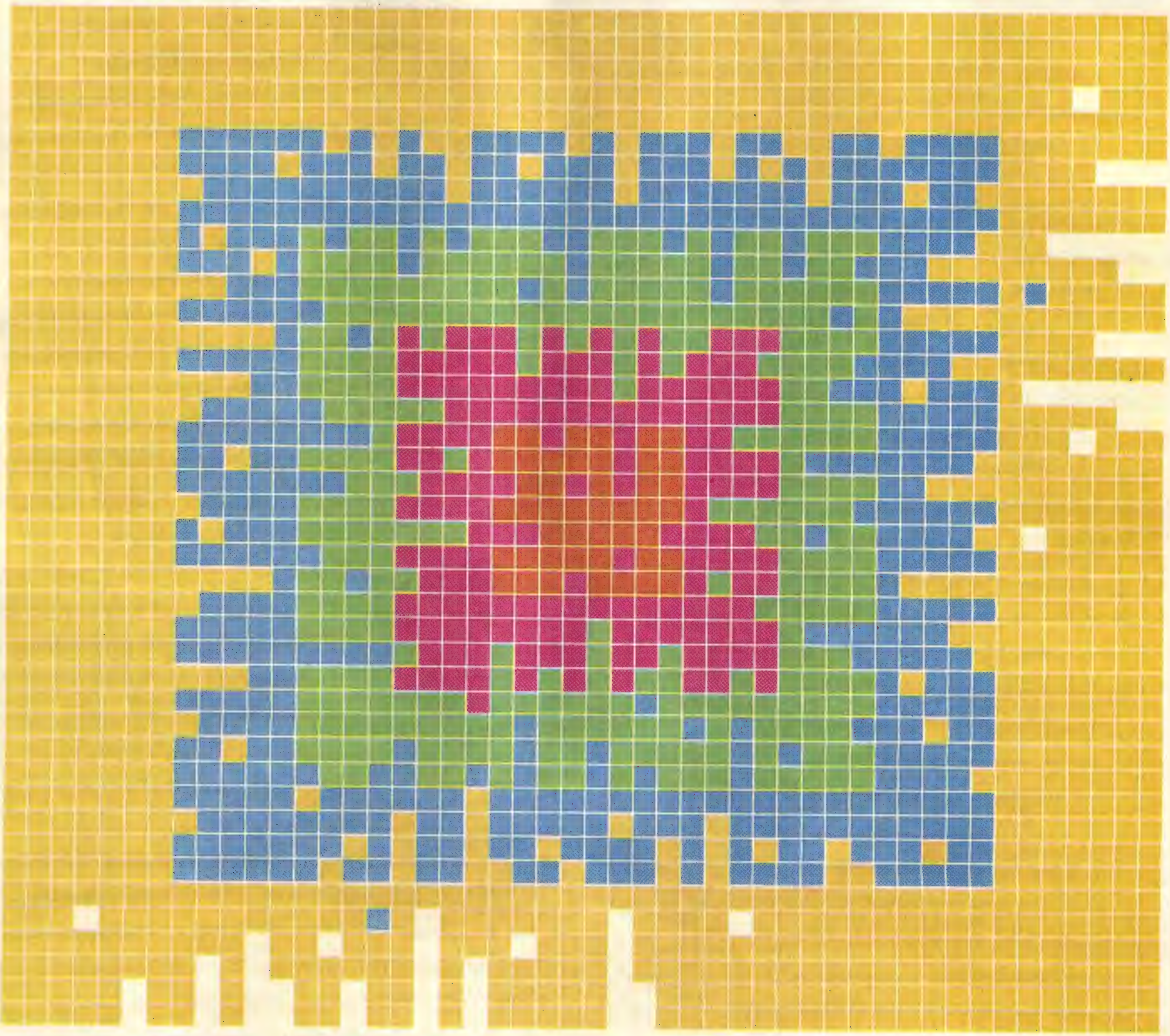
Expand to meet future needs The MSC 8001 is designed to accommodate a wide range of versatile configurations. Almost any combination of memory, inferface complement, and other options can be configured to meet your specific requirements without hardware modification. For additional information on the MSC 8001 and our other 41 Monolithic Systems Corp. products and systems, please contact us at 14 Inverness Drive East, Englewood, Colorado 80112. (303) 770-7400. Telex: 45-4498.

Monolithic Systems corp.

MULTIBUS is a trademark of Intel Corp.

Z80A is a trademark of Zilog, Inc.

Extending the limits of information.

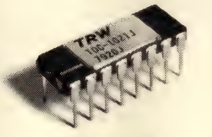


MSC International Sales Agents: England Coldata, Ltd., Tel.: 44-734-56446; **France** ASAP, Tel.: 331-604-78-78; **Holland/Benelux** Rodelco Electronics, Tel.: 31-70-995750; **New Zealand** David Reid Data Products, Ltd., Tel.: 64-9-499-107; **Switzerland** Amera Electronics, Tel.: 41-157-11-12; **West Germany** Semico Computer, Tel.: 49-6121-74433

CIRCLE NO. 172

Now... a monolithic 4-bit 30-megasample A/D converter

(And only $29 in 100s.)



ACTUAL SIZE

Our new, monolithic, bipolar 4-bit A/D does its work at a speed of 30 megasamples per second. Since it's fully parallel, it samples without the need for any external sample-and-hold circuit. And it's TTL compatible.

The chip packs 1,000 components, including 15 comparators and an output buffer register. It comes in a 16-pin package that's hardly bigger than a paperclip. And it draws only 250mW of power.

With specs like these, our new TDC-1021J is tailor-made for processors that go into facsimile systems, industrial video and ultrasound imaging. And the price makes the fit perfect: just $29, in 100s.

And that includes features like...

- ± ¼ LSB linearity
- Binary or two's complement output
- 30 psec aperture jitter
- Single convert signal

The TDC-1021J is available now from stock from Hamilton/Avnet.

For immediate information call (213) 535-1831 or send coupon. TRW keeps you ahead in digital signal processing.

TRW LSI Products
An Electronic Components Division of TRW Inc.
P.O. Box 1125
Redondo Beach, CA 90278

ED-5

Please send data on the new **TDC-1021J** 4-bit video speed monolithic A/D converter.

Name
Company
Div/Dept Mail Code
Address
City
State Zip

TRW LSI PRODUCTS
...for Digital Signal Processing

CIRCLE NO. 72

Solve design problems simply with 1.5 Amp Interface ICs for Negative Supply Applications.

You can use Sprague Electric's new Series UDN-2840B 1.5 amp monolithic quad power drivers in three basic versions to solve your circuit needs for (1) sinking applications, (2) source applications, and (3) combination sink-and-source applications.

You can get this versatile IC family with either 5V logic compatibility or 12-15V MOS compatibility. Make your choice from these six types:

TYPE	I_{OUT}	V_{OUT}(OFF)	OUTPUTS	$V_{SUPPLY\ (TYP)}$	COMPATIBILITY	TYPICAL APPLICATIONS
UDN-2841B	1.5 A	−50 V	Sink (4)	0 V to 5 V	5 V Logic	electrosensitive printer interface
UDN-2842B	1.5 A	−50 V	Sink (4)	0 V to 12 V	PMOS, CMOS	
UDN-2843B	−1.5 A	−50 V	Source (4)	5 V	5 V Logic	solenoid, LED, or relay drive
UDN-2844B	−1.5 A	−50 V	Source (4)	5 V to 12 V	PMOS, CMOS	
UDN-2845B	1.5 A/−1.5 A	−50 V	Sink (2) Source (2)	5 V	5 V Logic	bridge motor drives
UDN-2846B	1.5 A/−1.5 A	−50 V	Sink (2) Source (2)	5 V	PMOS, CMOS	

All Series UDN-2840B power driver ICs include input current limiting, level translation, and sufficient amplification to operate high current Darlington outputs. The Sprague-originated 16-lead webbed dual in-line package is used for maximum power dissipation.

For application engineering assistance on these or other interface circuits, standard or custom, write or call Paul Emerald, Semiconductor Division, Sprague Electric Co., 115 Northeast Cutoff, Worcester, Mass. 01606. Telephone 617/853-5000.

For Engineering Bulletin 29314 and a 'Quick Guide to Interface Circuits', write to: Technical Literature Service, Sprague Electric Company, 347 Marshall Street, North Adams, Mass. 01247.

For the name of your nearest Sprague Semiconductor Distributor, write or call Sprague Products Company Division, North Adams, Mass. 01247. Telephone 413/664-4481.

FOR FAST INFORMATION, CALL YOUR NEAREST SPRAGUE SALES OFFICE:

ALABAMA, Sprague Electric Co., 205/883-0520 • **ARIZONA**, Sprague Electric Co., 602/244-0154; 602/966-7233 • **CALIFORNIA**, Sprague Electric Co., 213 649-2600; 714/549-9913; R. D. Miner Co., 714/421-5586; Wm. J. Purdy Co., 415/347-7701 • **COLORADO**, Wm. J. Purdy Co., 303/777-1411 • **CONNECTICUT**, Sprague Electric Co., 203/261-2551; Ray Perron & Co., Inc., 203/268-9631; 203/673-4825 • **DIST. OF COLUMBIA**, Sprague Electric Co. (Govt. sales only), 202/337-7820 • **FLORIDA**, Sprague Electric Co., 305/831-3636 • **ILLINOIS**, Sprague Electric Co., 312/296-6620 • **INDIANA**, Sprague Electric Co., 317 253-4247 • **MARYLAND**, Sprague Electric Co., 301/792-7657 • **MASSACHUSETTS**, Sprague Electric Co., 617/899-9100; 413/664-4411; Ray Perron & Co., Inc., 617/969-8100 • **MICHIGAN**, Sprague Electric Co., 517/787-3934 • **MINNESOTA**, HMR, Inc., 612/831-7400 • **MISSOURI**, Sprague Electric Co., 314/781-2420 • **NEW HAMPSHIRE**, Ray Perron & Co., Inc., 603/742-2321 • **NEW JERSEY**, Sprague Electric Co., 201/696-8200; 609/795-2299; Trinkle Sales Inc., 609/795-4200 • **NEW MEXICO**, Wm. J. Purdy Co., 505/266-7959 • **NEW YORK**, Sprague Electric Co., 516/234-8700; 914/834-4439; 315/437-7311; Wm. Rutt, Inc., 914/834-8555; Paston-Hunter Co., Inc., 315/437-2843 • **NORTH CAROLINA**, Electronic Marketing Associates, 919/722-5151 • **OHIO**, Sprague Electric Co., 513/866-2170; Electronic Salesmasters, Inc., 800/362-2616 • **PENNSYLVANIA**, Sprague Electric Co., 215 467-5252; Trinkle Sales Inc., 215/922-2080 • **SOUTH CAROLINA**, Electronic Marketing Associates, 803/233-4637 • **TEXAS**, Sprague Electric Co., 214 235-1256 • **VIRGINIA**, Sprague Electric Co., 703-463-9161 • **WASHINGTON**, Sprague Electric Co., 206/632-7761 • **CANADA**, Sprague Electric of Canada, Ltd., 416 766-6123 or 613 238-2542.

4SS-9101R3

SPRAGUE®
THE MARK OF RELIABILITY

a subsidiary of **GK Technologies**
Incorporated

CIRCLE NO. 73

Besides dual-processor/dual-bus architecture for optimum throughput, a raster-scan display brings together a host of transformation features for manipulating and analyzing graphic images.

Fast raster-scan system displays graphics and images

A display system with a dual-processor/dual-bus architecture, the RM-9400, retains the attractive features of raster-scan technology—shading, color, remote workstations and multiple displays—while adding fast throughput and response. Combining microprocessor technology with versatile hardware ensures a flexible system and frees the host computer to supervise the more important tasks of the application itself. As for applications, special transformation features brought together by the raster-scan system make the fast RM-9400 suitable for a wide range of both graphics and imaging tasks.

As Fig. 1 shows, the RM-9400's processors and buses work hand-in-hand to speed things up. A display processor receives, interprets, stores and distributes command lists, while a memory-control processor draws graphic primitives into refresh memory. Meanwhile, a video bus interfaces the refresh memory and the scan electronics, while a computer interface bus links the host computer and the display system.

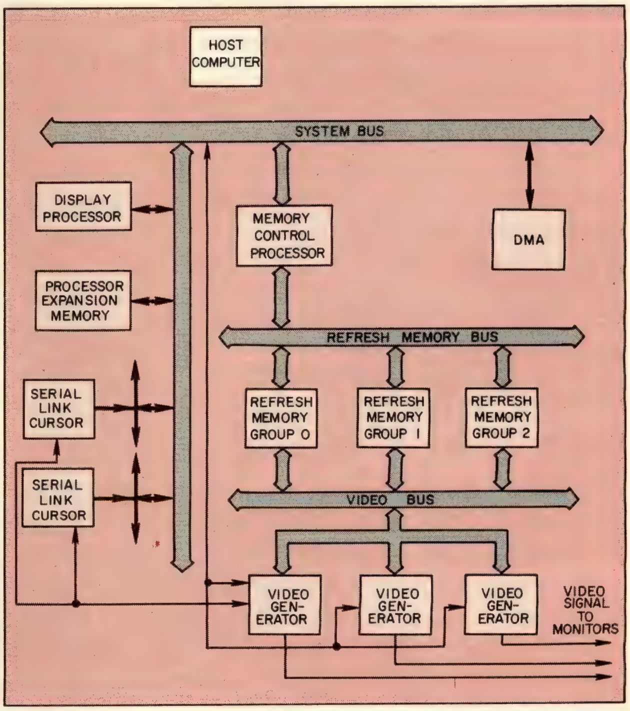
The display processor consists of a Zilog Z80A microcomputer that offers up to 512 kbytes of memory address space, paged in 4-kbyte increments. Based on the AMD-2900 bipolar 16-bit bit-slice μC, with its 56-bit microcoded word and 284-ns typical instruction execution, the memory-control processor typically allows the refresh memory to be written at an access time of 1.12 μs.

Getting optimum throughput

While the simultaneous operation of two processors does increase throughput, the fastest throughput stems from direct communication between the memory-control processor and the computer interface or the internal display-list memory. The display processor initiates this device-to-device communication, but an internal direct-memory-access sequencer controls the communication. As a result, the bandwidth of the system bus approaches 1-million 16-bit words.

The scan electronics, commonly called the video generator, incorporates the analog video and synchronization signals required to drive the CRT monitor. The configuration of the video generator tailors the display system to a specific application —with multiple generators, when necessary, to meet the demands of both graphics and imaging tasks.

The computer interface, a high-speed, 16-bit parallel bidirectional bus with a maximum bandwidth



1. The dual-processor and dual-bus architecture of the RM-9400 display system speeds up the throughput of raster-scan technology and simplifies interfacing to the host.

Stephen R. Johnson, Member of Technical Staff
Ramtek Corp.
2211 Lawson Lane, Santa Clara, CA 95050

of about 900 kwords a second, easily links the RM-9400 to a variety of computers (Fig. 2a). This general-purpose interface (GPIF) includes all the necessary command, status and data registers, as well as handshake and interrupt control circuitry, all of which minimize the logic design required to implement an interface.

Interfaces are available off-the-shelf for most minicomputers and some large mainframes. Most of these interfaces incorporate direct memory access or use the host's. Custom interfaces are also available, with maximum bandwidths of 1.5-million words a second.

A TTL-compatible interface, the GPIF is located on the RM-9400's display-processor assembly. As Fig. 2b shows, it consists of 22 signal lines to and from the host. All signal lines employ negative true logic. The 16 data lines (IOBIT00 through 15) are bidirectional, whereas the remaining six lines are unidirectional control signals. Since the host's signal edges are synchronized to an RM-9400 internal system clock, pulse widths are not critical, and GPIF timing is independent of the host. Fig. 2c indicates typical timing for I/O write and read signals.

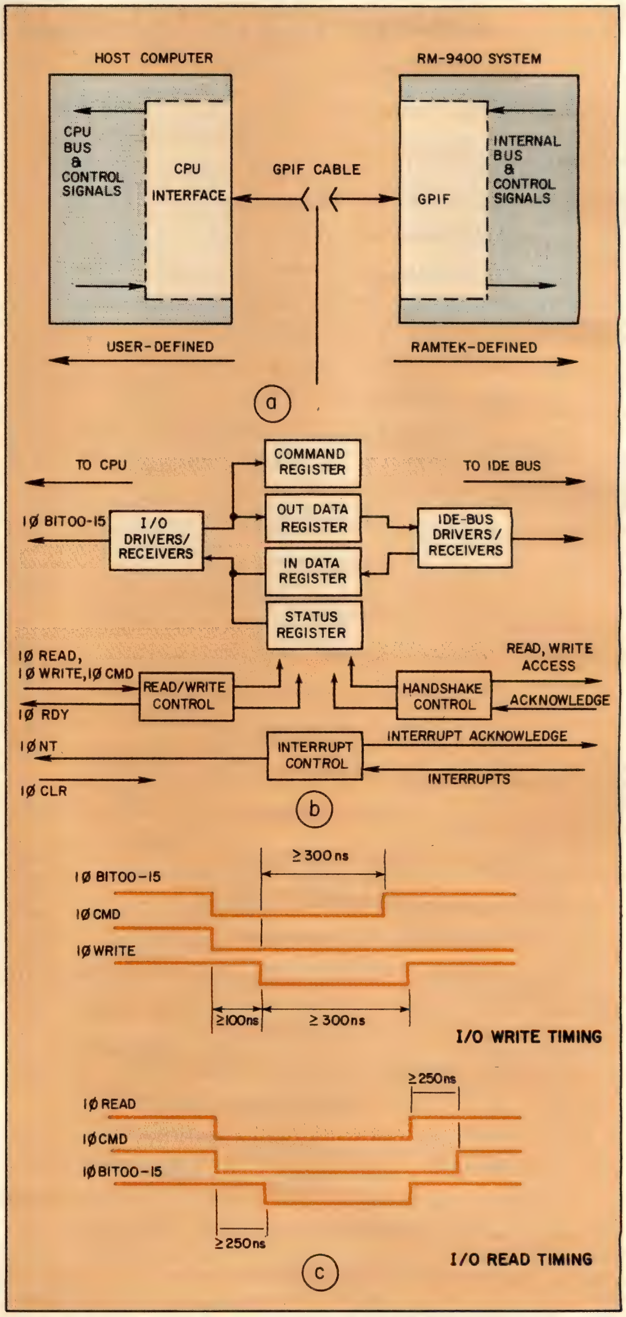
The RM-9400 decodes and processes a high-level binary-formatted instruction set. Although highly compact, these instructions are very flexible. Received instructions may be executed immediately or stored as subpictures in user (display list) memory for execution later. Whether executed in real time or deferred, the instructions directly or indirectly address a 32-k × 32-k display-coordinate system. It is even possible to downline-load display-processor control codes that might augment or redefine the RM-9400's instruction set for implementing local, application-oriented functions.

Different controller models in the RM-9400 family address various application needs, providing the medium resolution required for process control or the high resolution required for circuit design, satellite and pattern-recognition work. Spatial resolution, for example, ranges from 640 elements of 256 lines to 1280 elements of 1024 lines, at several different aspect ratios (see table).

Transforming coordinates is easy

One of the RM-9400's powerful capabilities permits the user to define his picture in terms of his own coordinate system, then project that picture on the display screen in terms of a fixed 32-k × 32-k virtual coordinate system. Called viewing (or coordinate) transformation, this feature (Fig. 3a) allows the RM-9400 to perform translation, two-dimensional rotation, scaling and other manipulations on graphic pictures.

Since such picture transformation does not affect line thickness, texture and character size, the RM-9400 can be used to superimpose and register predefined graphics against image frames. One fast-growing computer-graphics application that uses this feature is computer-aided design and drafting. Color graphics brings out details in complicated displays like design diagrams. Conceivably, a draftsman using a computer graphics system could produce five to 15 times more work than with traditional drafting techniques. What's more, the automated system provides output quality that is quite high.



2. A high-speed bidirectional bus links the RM-9400 to its host (a). This general-purpose interface consists of 22 signal lines (b) whose timing is independent of the host (c).

The RM-9400 can also simplify computer-aided design through an entity-detection feature that allows the host computer to identify objects, of any shape and size, pointed to by an operator. The operator steers a cursor to the desired object on the screen; this interrupts the host, and gives it the cursor coordinates. The host then simply establishes a detection window about the cursor position, activates the RM-9400's entity-detection mode, and invokes the display list that created the picture. The RM-9400 responds with information identifying the object for the host and points to the instructions in the display list that created the object.

Able to do computer-aided design and drafting, the RM-9400 proves just as proficient at automated mapping, a similar—but more demanding—application. Maps usually represent objects offering more varied and changing information than mechanical or electrical parts. Once stored in refresh memory, the picture may be enlarged via nondestructive panning and zooming. This spatial-transformation capability (Fig. 3b) permits a user to view a segment of the picture, and also to pan around the larger picture.

Not only that, but unlike most contemporary display equipment, the RM-9400 permits picture-zooming in both the X and Y axes in integer steps from one to 16, with smooth transitions from one step to the next as the picture gets larger. As a result, more useful zoom steps are attained than with binarily incremented zoom ratios.

The ability to enlarge and enhance an image suits the RM-9400 to imaging applications as well as graphic applications. Inputs may be generated, in various formats, by TV cameras or other remote sensing devices. With raster-scan image processing, mathematical transformations are performed on various attributes of the image data to enhance particular features visually; this way, they can be detected, extracted, or otherwise analyzed.

Imaging applications range far and wide for the RM-9400: processing satellite pictures of the earth's surface, to detect areas infested with plant disease; medical diagnosis involving the analysis of ultrasonic and computer-assisted tomographic data, to reveal growths and diseases; military intelligence, to see through camouflage and detect objects of military interest in aerial and satellite photographs; and graphic art, for photocomposition and color separation.

Some applications take advantage of the RM-9400's dual imaging and graphics capabilities—for example, weather analysis and forecasting. The display might show cloud cover or storm fronts registered against a graphic map of the coastline.

Decluttering streamlines the display

As a picture is retransformed, another feature, called decluttering, can be used to add or subtract details while enlarging or reducing the picture. In general, decluttering makes it possible to classify information from a command list (apply a draw filter), by controlling visibility on the display screen (possibly as a function of scale or other criteria).

Decluttering could prove especially useful to domestic-information display and electronic-circuit design. Once stored in a computer system, a map can serve as a two-dimensional index to the information associated with the geography. For instance, by pointing to a parcel of land on a property-map display, a tax assessor could receive a printout of land improvements, assessed value and other such data. The Census Bureau could use the system, say, to analyze various population shifts.

In circuit design, the operator could view single masks of an integrated circuit or a given layer of a multilayer printed-circuit board by using separate colors to represent the different layers of the board. This technique would give the engineer a quick look during error checking, and consequently minimize the time-consuming requirement for multiple-pen plots as a design proceeds.

Yet another feature, clipping, allows graphic pictures to be restricted to an arbitrary rectangular viewport in the refresh memory. Because a viewport can be exceeded as a picture is enlarged (scaled), the clipping capability suppresses all information outside the clip window. This feature should prove convenient to a command-and-control operation

RM-9400 resolution values

Controller model (RM-9400/nX)	Spatial resolution		Aspect ratio (X:Y)		Refresh frequency (frame rate)
	Lines	Elements	Raster	Pixel	
RM-9400/1X	256	640	4:3	2:1	50/60-Hz repeat field
RM-9400/3X	512	640	4:3	1:1	25/30-Hz interlaced
RM-9400/5X	512	640	4:3	1:1	50/60-Hz repeat field
RM-9400/7X	512	1280	4:3	2:1	50/60-Hz repeat field
RM-9400/8X	1024	1024	1:1*	1:1	25/30-Hz interlaced
RM-9400/9X	1024	1280	4:3	1:1	25/30-Hz interlaced

*Active raster is centered within 4:3 CRT aspect ratio

Microprocessor System Builders:

Here's how to improve your productivity

Clip on the interactive AQ8080Z Microprocessor System Analyzer.

- Buffered probe clips on in seconds. Your chip stays in its socket — can even be soldered in.
- Test your *complete* system, intact.
- Modify or examine all internal registers, memory, and I/O ports.
- Real-time hardware breakpoint or monitor
- Hardware breakpoint on contents of any selected register or memory location.

The portable AQ8080Z is ideal for:

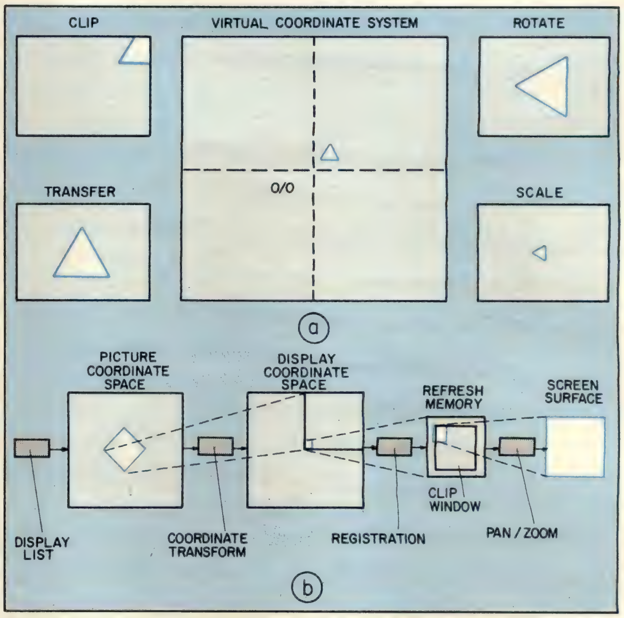
- Hardware / software debugging
- Small scale software development
- QA and production testing
- Field service and depot testing

Field proven in over three years of regular use. Call or write today for a new six page technical brochure describing the AQ8080Z, for Z80A, 8080A, and 8085A systems. If you're a 6800 or 6802 user, request the AQ6800 brochure.

AQ SYSTEMS, INC.

1736 FRONT STREET, YORKTOWN HEIGHTS, N.Y. 10598
(914) 962-4264

CIRCLE NO. 74



3. With a special feature called viewing transformation (a), the RM-9400 can translate, rotate and scale pictures. Another feature, spatial transformation (b), permits the user not only to view a segment of the picture but also to pan around the larger picture.

where situation-map displays would enable viewing of tactical environments like troop deployments and aircraft strikes. With this clipping feature, an area of the display screen may be reserved for information other than graphics, such as system communication data or text information providing descriptions of the graphics displayed.

The RM-9400 also enables extensive user-assignable internal capabilities to be implemented. A display-list option, for example, allows pictures or subpictures to be downline-loaded and called as graphic subroutines. Consequently, picture manipulations, such as transformations, may be performed locally. Correspondingly, a local-functions feature allows linking the pictures or subpictures (display lists) to function keys on a keyboard.

An example of utilizing this interactive capability might involve a process-control application in a power station or petrochemical plant. Here, the graphics system might be used as an output device to display the status of whatever process is being examined. When used interactively, the system might cause a condition change that would preclude the physical act of throwing a breaker or closing a valve. Instead, this activity could be automated and accomplished from a display console.□

How useful?	**Circle No.**
Immediate design application	556
Within the next year	557
Not applicable	558

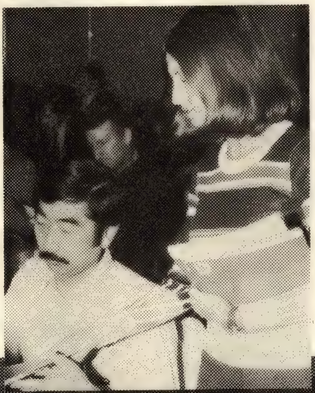
Electronic Design
is pleased to announce:

Introducing the ICs of the 1980s

A conference devoted to the introduction of new ICs and the discussion of ways to apply them

If you use ICs, this conference provides an unusual opportunity to hear new devices announced and to learn about the latest techniques for designing with them. Each talk is presented by an applications engineer at a major manufacturer of integrated circuits. Each registrant receives a package of IC application literature including an in-depth proceedings.

JUNE 16-20, 1980
Culver City Ramada Inn
At San Diego Freeway
San Diego Freeway Exits
Lawson (from North);
Centinela (from South)
6333 Bristol Parkway,
Culver City, CA



JULY 21-25, 1980
Newton Holiday Inn
At Exit 53 Off Route 128
399 Grove Street
Newton Lower Falls, MA

LOS ANGELES
June 16-20, 1980

NEWTON, MA
July 21-25, 1980

The IC Industry and **Electronic Design**
presents a conference for IC users

Introducing the ICs of the 1980s

All speakers at this conference are from IC manufacturers. Their talks introduce new ICs and describe application techniques that can help speed the acceptance of these products into the programs and plans of IC users. In covering how new ICs change existing system design concepts, the talks convey the very latest IC application philosophies to conference attendees.

The conference attendees will:

- Hear exciting new ICs described for the first time.
- Receive a library of literature and materials including an in-depth proceedings, applications manuals, and data loose-leaf books.
- Meet speakers and fellow attendees at two cocktail receptions (Tuesday and Wednesday).
- Participate in practical demonstrations of prototype systems, development stations, IC support tools, and microcomputer boards.

Registration fee includes the proceedings and other related materials, in addition to lunch each day, coffee, danish, and soft drinks. Each day's program starts at 8:30 A.M. and ends at 4:30 P.M. Hotel accommodations are available for out-of-town registrants.

Conference Sites:
June 16-20: Culver City Ramada Inn (near L.A. International Airport)
July 21-25: Newton Holiday Inn (on Route 128 near Massachusetts Turnpike)
For hotel overnight accommodations, call:
Culver City Ramada Inn: 213-670-3200
Newton Holiday Inn: 617-969-5300

MONDAY/LINEAR I

Three New Linear Families. New video SOS a/d flash converters, CA3179 1.3-GHz prescaler, divide-by-4 prescaler and precision BIMOS op amps are introduced. Hal Wittlinger, RCA, Somerville, N.J.

ICL7650 Glitchless Chopper-Stabilized Amplifier. Offers low offset voltage and exceptionally low input bias current at a very attractive price. Skip Osgood, Intersil, Cupertino, CA.

Am6300 Power-Supply-Control Subsystem. Computer-controlled, power-supply controller for sophisticated power-supply systems. Brian Gillings, Advanced Micro Devices, Sunnyvale, CA.

National's New Developments. A look at new low-power references, high-power regulators, and precision op amps coming from National Semiconductor.

DG211 4-Channel Switch. Fits a variety of low-cost applications. Jerry Mandel, Tom Cate. Siliconix, Santa Clara, CA.

CMOS Voltage Regulators, References and Voltage Detectors. Micropower devices covered include two-terminal voltage references, positive and negative programmable regulators and over-and-under voltage detectors. Jerry Zis, Intersil, Cupertino, CA.

New Voltage/Frequency Converter Techniques. New techniques lead to 18-bit a/d conversion with 1 ppm/°C gain stability. A 1.3-V (single-cell) supply circuit is also discussed. Bob Pease, National Semiconductor, Santa Clara, CA.

Analog/Digital LSI Design With I^2L Gate Arrays. A cost-effective approach. Bill O'Neil, Exar, Sunnyvale, CA.

RM4200 Analog Multiplier. Applications for a precision monolithic multiplier/divider are covered. Jim Schmoock, Raytheon Semiconductor, Mountain View, CA.

TUESDAY/LINEAR II

The HI5900 and HI5712: A Complete Microprocessor-Compatible System. An analog signal-processing front end and a 12-bit a/d converter form a high-speed, high-performance data-acquisition system. Al Morton and Rich Antalik, Harris Semiconductor, Melbourne, FL.

New Texas Instruments' Op Amps and Interface Circuits. Discusses single-supply, n-channel, FET-input op amps, comparators, new EIA RS-422 line circuits and 3-A peripheral drivers. Dale Pippenger, Texas Instruments, Dallas, TX.

BUF-03: Industry's Fastest Voltage-Follower Amplifier. Boasts a 300-V/μs slew rate and 55-MHz bandwidth. Two applications are described. With an OP-16, it forms a current booster capable of driving heavy capacitive loads; with a 500-pF holding capacitor, it functions as a fast sample-and-hold amplifier. Shelby Givens, Precision Monolithics, Santa Clara, CA.

9708 8-Bit, 6-Channel A/D Converter and 9706 12-Bit 8-Channel D/A Converter. Use in microprocessor-based control systems described. John Conover, Fairchild Semiconductor, Mountain View, CA.

OP-220 Dual Micro-Power Op Amp. Industry's first low-power, high-precision dual op amp. Lowest input offset voltage, lowest bias current over temperature, and lowest input-offset-voltage temperature coefficient of any dual amplifier. CMVR includes ground which makes this device ideal for light, compact battery-operated instrumentation. Tom Schwartz, Precision Monolithics, Santa Clara, CA.

Microprocessor-Compatible Conversion ICs. Discussion of new a/d and d/a converters and sample-and-hold amplifiers. Steve Sockolov and Phil Marcoux. Signetics, Sunnyvale, CA.

New Motorola Industrial ICs. Describes IC drive system for stepper motors. Speakers to be announced. Motorola, Phoenix, AZ.

Monolithic ICs for FSK Modem Design. A two-chip FSK modem design. Joel Silverman, Exar, Sunnyvale, CA.

Power Interface Circuits. Introduces UDN-2949Z bipolar half-bridge motor driver and UCN-4202A stepper motor translator/driver. Paul Emerald, Sprague, Worcester, MA.

WEDNESDAY/MICROPROCESSORS I

Microcomputers From Intel in the 1980s. Integrating software into silicon; simplifying the interface to the user. Dane Elliot, Intel, Santa Clara, CA.

Introduction to Signal-Processor ICs. Features, architecture and instruction set described. Bob Holm, Intel, Santa Clara, CA.

The Intel 2920 Signal Processor. A discussion of 2920 applications. Bob Holm, Intel, Santa Clara, CA.

Microcontrollers: System-Designed

A conference organized
by **Electronic Design**
to help introduce new ICs
and show how to
apply them for
optimum performance

Microcomputers. New signal processors and microprocessors. Dick Barck, American Microsystems, Cupertino, CA. Santa Clara, CA.

The S68045 CRT controller. Reduces CRT system cost *design*. Frank Toth, American Microsystems, Santa Clara, CA.

Motorola's New Family of CMOS Microprocessors. Five new CMOS ICs with a/d converter, RAM, ROM and EPROM on the chips. Jim Farrell, Motorola, Austin, TX.

Fast Error Detection and Correction for Memory Systems. Use of AM2960 16-bit EDC IC is described. John Mick, Advanced Micro Devices, Sunnyvale, CA.

MB1412A 8-bit-slice ECC IC. Use of error-checking-and-correction chip described. Alan Heimlich, Fujitsu Microelectronics, Sunnyvale, CA.

THURSDAY/MICROPROCESSOR II

The NS16000 Family: Support for Software Modularity. NS16000 architecture eliminates the need to modify machine code. Linking process illustrated. Brian Marley, National Semiconductor, Santa Clara, CA.

Software Solutions for Board Applications. The software exists to design your next microprocessor-based board product. Joanne Pearson, Intel, Santa Clara, CA.

Transparent Addressing Resolves Memory Contention in Terminal Application. SY6545 allows addressing of screen-refresh memory transparent to processor to improve overall design efficiency. Conrad Boisvert, Synertek, Santa Clara, CA.

Mask-Programmable Low-Power-Schottky Gate Array. Shrinking system design. Cliff Vaughan, Raytheon Semiconductor, Mountain View, CA.

2653 Polynomial Generator Checker. Performs block/check character and parity generation, checking, single-character detection and two-character sequence detection. Alex Goldberger, Signetics, Sunnyvale, CA.

Bipolar Arithmetic Devices Support New MOS Microprocessor. Multiplier/divider enhances performance of otherwise slow MOS microprocessor. Shlomo Waser, Monolithic Memories, Sunnyvale, CA.

NE5560 Switched-Mode Power-Supply Control Circuit. For flyback forward or double forward (push-pull) outputs, provides all control interfacing needed. Norm Matzen, Signetics, Sunnyvale, CA.

Leadless Carrier Memory Arrays. Describes applications techniques. Charles Hochstedler and Jeff Wilkinson, Harris Semiconductor, Melbourne, FL.

FRIDAY/MICROPROCESSOR III

Single-Chip Fairchild Microcomputers. Describes applications for currently available F3870 devices and explores the use of tomorrow's multiple-function-on-a chip ICs. Jim Lang, Fairchild Semiconductor, So. San Jose, CA.

NSC800 In Low-Power Systems. Uses new high-density CMOS process called P^2CMOS. An 8-bit CPU and supporting components are covered. Keith Winter, National Semiconductor, Santa Clara, CA.

Design and Use of Mostek PROM Programming Unit. Applies MK3873 single-chip microcomputer. Don Folkes, Mostek, Carrollton, TX.

The CONCEPT-48 Development Tool. Single-board system for 80C48 family. Gopal Ramachandran, Intersil, Cupertino, CA.

Z80 As a Versatile Communications Device. Z80 FIO as used in BiSync, HDLC, and SDLC communications protocols. James Booth, Mostek, Carrollton, TX.

PALs Replace Random Logic in Microprocessor Designs. Use of PAL series 20 to replace 7400 series MSI/LSI devices in microprocessor applications. Saeed Kahmi, Monolithic Memories, Sunnyvale, CA.

NS16000 Supports Virtual Memory. Virtual memory, a mainframe concept in the past, is applicable to microprocessor-based designs thanks to the 16000 microprocessor. Su Bhash Dal, National Semiconductor, Santa Clara, CA.

Electronic Design Conference
P.O. Box 1021
Melville, N.Y. 11747

Please register me for:
☐ Entire conference, Mon. through Fri. Fee: $350.
☐ Linear sessions, Mon. and Tues. Fee: $150.
☐ Microprocessor sessions. Wed. through Fri. Fee: $225.

I prefer to register for the following days @ $75 per day:

__________ __________ __________ __________

I will attend in:
☐ Culver City, Week of June 16–20, 1980
☐ Newton, Week of July 21–25, 1980

Can't Attend In Person?
☐ Send linear proceedings. $85 check enclosed.
☐ Send microprocessor proceedings. $95 check enclosed.
☐ Send both proceedings. $175 check enclosed.

Name ____________________ Title ____________________

Company ____________________

Street ____________________

City ____________________ State __________ Zip __________

Signature ____________________

☐ Check enclosed ☐ Will pay at door

Make check payable to Electronic Design Conferences

Solitron Offers The Most Complete Line Of

SINGLE DIFFUSED POWER TRANSISTORS:

☐ DISCRETE ☐ HIGH VOLTAGE

☐ DARLINGTON ☐ JAN, JANTX

TYPE	V_{CEO} Volts	h_{FE} Min/Max	I_C Amps	$I_{S/B}$ @ V_{CE} Volts	I_C Amps	Pulse (sec)	Power Watts	Case Style
SDT 31303	200	10/50	2.0	200	1.25	1.0	250	T0-3
SDT 31305	250	10/50	2.0	250	1.0	1.0	250	T0-3
SDT 31307	300	10/50	2.0	250	1.0	1.0	250	T0-3
SDM 4003 1)	80	1000 Min	4.0	60	1.95	1.0	117	T0-3
SDM 4013 1)	160	1000 Min	2.0	100	1.17	1.0	117	T0-3
SDM 5003 1)	80	1500 Min	6.0	60	2.5	1.0	150	T0-3
SDM 5013 1)	160	1000 Min	4.0	100	1.5	1.0	150	T0-3
2N 6259	150	15/60	8.0	100	2.5	1.0	250	T0-3
2N 6258	80	20/60	15.0	80	3.1	1.0	250	T0-3
2N 3773	140	15/16	8.0	100	1.5	1.0	150	T0-3
2N 3772 2)	60	15/60	10.0	60	2.5	1.0	150	T0-3
2N 3771 2)	40	15/60	15.0	40	3.75	1.0	150	T0-3
2N 6254	80	20/70	5.0	80	1.87	1.0	150	T0-3
2N 3055H 2) 3)	60	20/70	4.0	60	1.95	1.0	117	T0-3
SDT 3055	60	20/70	4.0	40	2.92	1.0	117	T0-3
2N 5496	70	20/100	3.5	70	0.714	1.0	50	T0-220
2N 5298	60	20/80	1.5	60	0.60	1.0	36	T0-220
2N 3441	140	25/100	0.5	120	0.208	1.0	25	T0-66
2N 3054	55	25/100	0.5	55	0.45	1.0	25	T0-66

1) Darlingtons 2) Also Available as JAN, JANTX 3) Suffix "H" denotes full SOA at max. VCEO rating of 60V

Rugged reliability. Superior performance. That's what you'll get with Solitron's single diffused NPN silicon power transistors. They're ideal for power supplies, audio power stages, series and shunt regulators, inverters . . . for any tough linear application.

These transistors feature low sat voltages, high DC current gain, high power dissipation and excellent SOA's. Each one is 100% power pulse tested and highly resistant to secondary breakdown. And, all are low priced and available for immediate shipment.

Our expanded line offers a lot more types than we show here.

Dial 1-800-327-8462

toll-free for further information. Or contact your local Solitron distributor.

Solitron
DEVICES, INC.
1177 Blue Heron Blvd.
Riviera Beach, Florida 33404
(305) 848-4311 / TWX: (510) 952-7610 / TELEX: 51-3435

CIRCLE NO. 75

μP-based smart terminals come "factory-programmed" to perform certain operations. But as the systems designer will discover, there's much more capability built-in—and he can make the modifications.

Smart terminals fit special applications

Microprocessor-based smart terminals should not be taken at face value: They offer systems designers something above and beyond the features designated by the manufacturer—the built-in flexibility to make them more capable. Depending on the particular device, the designer may look beyond the published specs and fit the terminal to a specific application in several ways, including:

- Reprogramming terminal firmware
- Modifying personality attributes assigned at manufacture
- Reprogramming function-key operations
- Redefining the keyboard.

Normally, the designer asks the terminal manufacturer to make changes in the firmware and thus modify manufacturer-designated operations to accommodate special requirements. However, if the designer plans to make field changes—say, replacing the manufacturer's protocol with one compatible with a different mainframe—terminal architecture becomes important. In this case, modularity could become a useful modification tool. With a modular program, the designer can redesign one module without affecting the rest of the program.

A more frequently used way to modify the smart terminal is to alter the personality traits within the framework of the original design. Fig. 1 shows a sample of personality features, along with the commands to alter them, for the ADM-42.

The system designer can specify personality features to occur at power-up. If changes are required later in the field, the features can easily be replaced. However, a more common alternative is to modify the terminal while it is running, using commands from the host computer. The CPU sends down a sequence of characters to change the attributes. That way, if not modified by the host, the terminal will retain its "factory-installed" identity until a change is needed.

It's in the memory

In the ADM-42, the standard personality is implemented in PROM (Fig. 2). On power-up, the contents of the PROM are copied into a work area in RAM. Consequently, dynamic personality changes can be made simply by changing the contents of the RAM. To execute the dynamic functions, which are program-defined, the RAM first must be accessed—this determines the current state of the personality. This process, called default personality, is implemented in a fixed memory location. The work performed on the copy of the personality is maintained temporarily in the RAM.

Such a process occurs, say, when modifying a response to a carriage-return code to tailor a particular application. In the standard configuration, the return code moves the cursor from the current position to the left margin on the current vertical line. In some applications, however, it may make more sense to erase the remainder of the line and move to the beginning of the next line.

In practice, a personality instruction tells the terminal to erase the rest of the line once the return code is processed. If that bit is set in the personality, the line is erased. If it is not set, the cursor moves to the beginning of the current line.

To see how a personality change is implemented in the ADM-42, examine the following example.

The standard transmission terminator is CR, which indicates to the system that the transmission is complete. The end of the line indicator is US. But suppose the system designer wants to alter the procedure so that in a multiline transmission, a 1F CR sequence indicates the end of the line with more text to follow, and a CR, when not preceded by LF, indicates the end of the complete transmission.

Catherine Raferty, Product Marketing Manager
Douglas H. Thompson, Director of R&D
Lear-Siegler, Inc., Data Products Div.
714 N. Brookhurst St., Anaheim, CA 92803

Byte	Bit	ADM-42 personality Description	Std value ASCII	Hex
1	All	First character of end-of-block send sequence in nonpolled block transmissions and cursor-coordinate send. NUL (00) means no sequence transmitted.	CR	0D
2	All	Second character of end-of-block send sequence. NUL (00) means no second character.	NUL	00
3	All	First character of end-of-line sequence. (If UL, no end line.)	US	IF
4	All	Second character of end-of-line sequence. (If NUL, no second character.)	NUL	00
7	All	Error-replacement character: Bits 6-0 form an ASCII character substituted for a character received with parity or overrun error condition if NUL (00) no-replacement tabs place. Bit 7 controls display of error messages on status line. 0=no display, 1=display.	NUL	00
		Byte 10		
		When bit is on	**Std default**	
10	3	Disables scroll operation.	Off	
	3	Protected field delimiter FS is transmitted after the unprotected field, not after the protected fields.	Off	
		Description	**Std value**	
5	All	Field separator: Character transmitted for a protected field when in PROT mode.	FS	1C
B		Polling variants: a set of bit-coded control variations for use primarily in the poll/select-option operation.		00
		Function		
	5	Print-buffer enable for poll/select.		
	6	Communication buffer for polling.		
E		Miscellaneous lookouts and enables.		
		Function		
	0	Inhibit keyboard function key change.		
	1	Skip after Load.		
	2	—		
	3	Inhibit auto video time out		
	4	Inhibit line wrap.		
	5	Auto FL with CR.		
	6	Auto line erase with CR.		
	7	Inhibit keyboard personality change.		

1. **Personality features and commands for the ADM-42 can be changed at power-up, from the host or the keyboard. The popular way is for the designer to modify the terminal.**

Personality bytes 1 through 4 control end-of-block transmissions and end-of-line characters. Bytes 1 and 2 define the first and second end of block characters. Since the standard default for byte 1 is CR and byte 2 is NUL, no change is required in bytes 1 or 2. Bytes 3 and 4 define the first and second end-of-line characters. Byte 1 defaults to US and byte 2 to NUL. These two bytes are changed to 1F and CR, respectively, by entering the following sequence at the keyboard or by transmitting the sequence to the terminal:

ESC (escape) .30A ESC .40D

In another example, personality byte E (Fig. 2) is bit-coded to control several functional characteristics:

Bit	0	Inhibit keyboard function key change
	1	Skip after Load
	2	-
	3	Inhibit auto video timeout
	4	Inhibit line wrap
	5	Auto LF with CR
	6	Auto line erase with CR
	7	Inhibit keyboard personality change

In the standard default condition, bit 3 is on, while all other bits are off, which inhibits video timeout in the standard program. Now, suppose that the designer wants to have the remainder of each line erased when the CR code is received and to position the cursor at the beginning of the next line. When on, bit 5 automatically transmits a line feed with carriage return, and bit 6 erases the remainder of the line when CR is detected. Therefore, to implement change, byte E is changed from 00001000 = hex 08 to 01101000 = hex 68 by entering ESC . E68 at the keyboard or by transmitting this sequence.

Keys to the changes

A third way to alter a smart display terminal, modifying the function keys, can be done by leading a sequence of codes into them. Say, for example, that an often-used phrase entered on a regular form or displayed on the screen is ten characters long. This sequence can be stored in function-key memory so that every time the function is activated, the string of characters will be put onto the screen at the current position of the cursor. The character string can also be sent to the printer port or can be transmitted without being entered onto the screen.

Incidentally, this character string could be a mix of text and commands or all text or all commands. For example, under function-key control, a small amount of text may be entered into a specific area on the display screen. A command positions the cursor to a particular point on the screen where the text is to be displayed. Through another command, the cursor is repositioned elsewhere on the screen.

Smart vs dumb

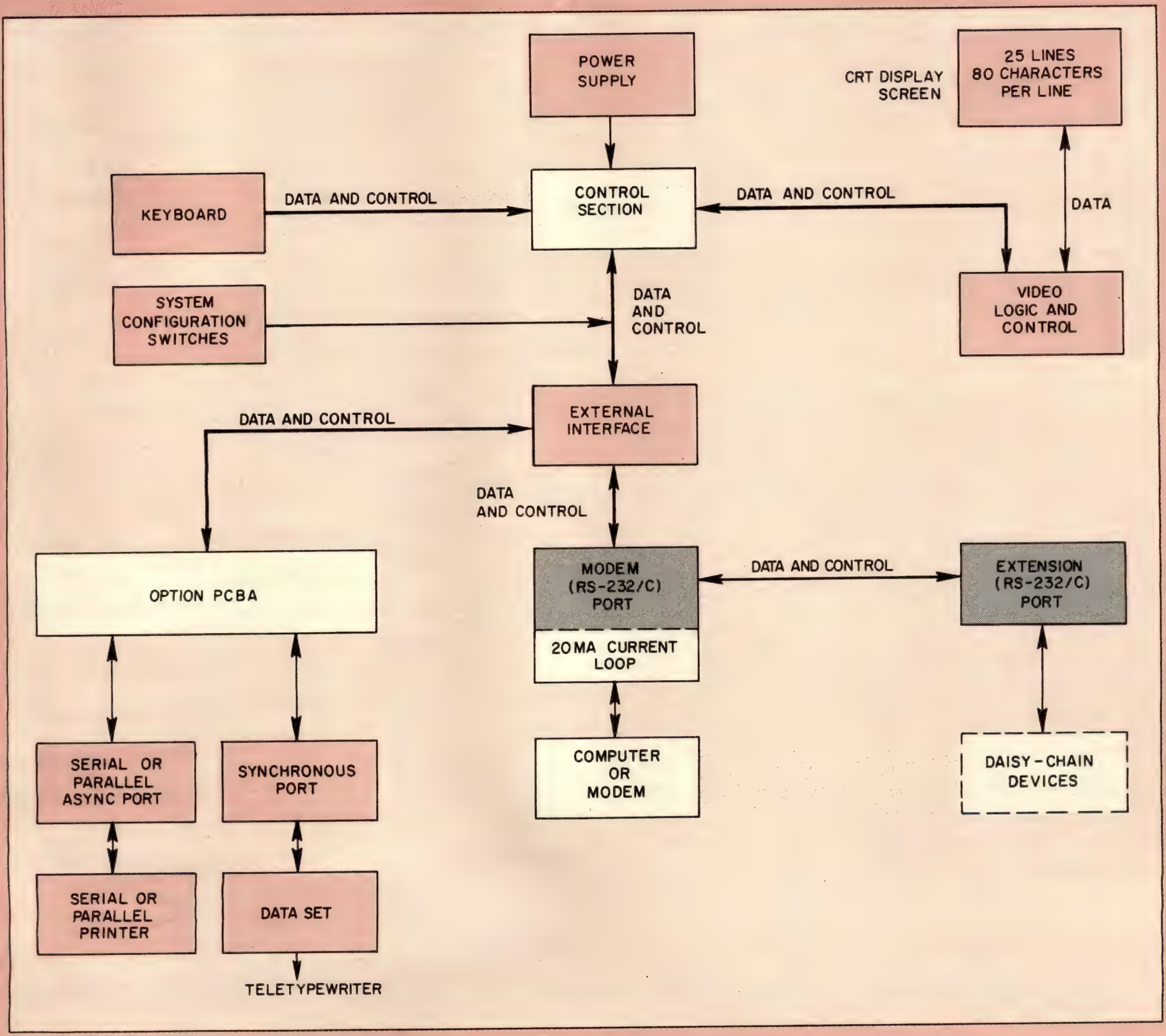
A terminal like the Lear-Siegler ADM-42 enables users not only to communicate with a wide range of remote devices but also to control the content and format of data entered via the keyboard. How? By being smart, not dumb.

A dumb terminal consists of a keyboard and a screen for basic I/O, an interface to a communications line—and very little else. Once data are entered at the keyboard, the terminal is limited to displaying and transmitting codes to the computer, which are then interpreted by the host for subsequent transmission and display. Any intelligence involved is in the device interfacing with the terminal.

A smart terminal, on the other hand, has enough capability (see Fig.) to put data directly onto the display screen from the keyboard without help from the host. What's more, by providing features like data formatting, highlighting and text editing, it allows the data to be modified before block transmission to the host.

In addition, a smart terminal supports peripheral devices such as printers or mass-storage devices, and transfers displayed information to the off-line storage device. It also buffers information being sent to a printer or another peripheral device connected to the terminal.

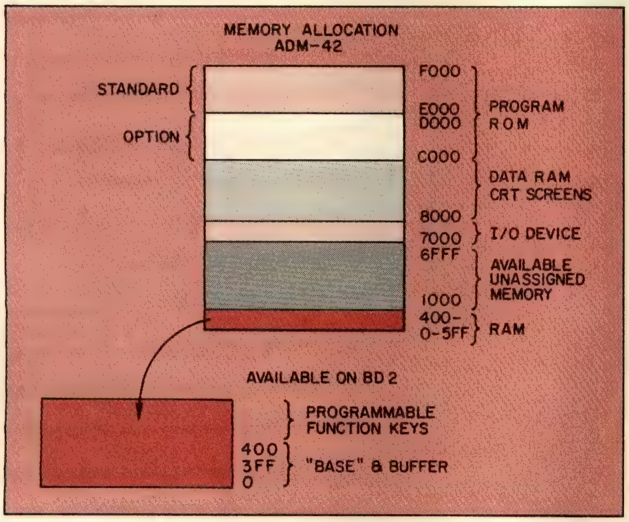
Many independently controlled and executed optional features are usually provided in smart terminals, each requiring additions and/or alterations to standard terminals. These include memory extension for display storage, function-key sequences, personality modifications, answer-back, optional character-generator sets and modification of the standard program.



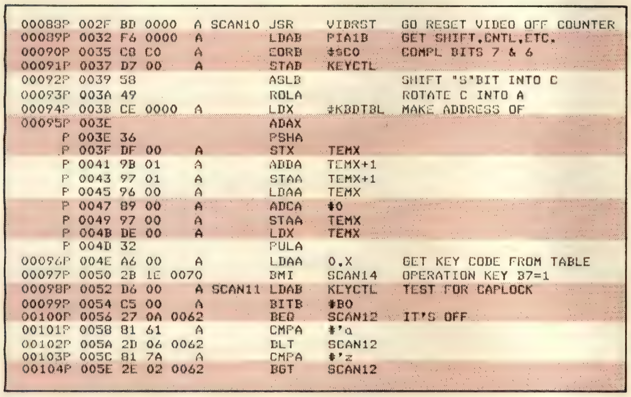
Another small amount of text is then entered, the cursor is repositioned to the end of the screen, and a command is issued, sending the screen's data to the computer. When a function key is programmed in this way, a single key stroke will enter text at two locations on the screen and cause page transmission.

Normal "unprogrammed" function keys cause a three or four-character sequence to be sent to the computer. For example,

Char 1	Function lead from personality 6
Char 2	Unique character
Char 3	Personality 1
Char 4	Personality 2 if not 00 (NUL)



2. Memory allocations in the terminal help the user determine how to change the personality of the terminals. With dynamic functions, the RAM must first be accessed for default personality.



```
00088P 002F BD 0000  A SCAN10 JSR    VIDRST   GO RESET VIDEO OFF COUNTER
00089P 0032 F6 0000  A        LDAB   PIA1B    GET SHIFT.CNTL.ETC.
00090P 0035 C8 C0    A        EORB   #$C0     COMPL BITS 7 & 6
00091P 0037 D7 00    A        STAB   KEYCTL
00092P 0039 58                ASLB            SHIFT "S"BIT INTO C
00093P 003A 49                ROLA            ROTATE C INTO A
00094P 003B CE 0000  A        LDX    #KBDTBL  MAKE ADDRESS OF
00095P 003E                   ADAX
     P 003E 36                PSHA
     P 003F DF 00    A        STX    TEMX
     P 0041 9B 01    A        ADDA   TEMX+1
     P 0043 97 01    A        STAA   TEMX+1
     P 0045 96 00    A        LDAA   TEMX
     P 0047 89 00    A        ADCA   #0
     P 0049 97 00    A        STAA   TEMX
     P 004B DE 00    A        LDX    TEMX
     P 004D 32                PULA
00096P 004E A6 00    A        LDAA   0.X      GET KEY CODE FROM TABLE
00097P 0050 2B 1E 0070        BMI    SCAN14   OPERATION KEY B7=1
00098P 0052 D6 00    A SCAN11 LDAB   KEYCTL   TEST FOR CAPLOCK
00099P 0054 C5 00    A        BITB   #B0
00100P 0056 27 0A 0062        BEQ    SCAN12   IT'S OFF
00101P 0058 81 61    A        CMPA   #'a
00102P 005A 2D 06 0062        BLT    SCAN12
00103P 005C 81 7A    A        CMPA   #'z
00104P 005E 2E 02 0062        BGT    SCAN12
```

3. Source code is provided by the manufacturer for modifying the terminal. This partial listing of the ADM-42 source code is a keyboard-scan routine that starts at the last key number and runs to the character table.

In applications where frequently used character sequences are sent to the computer or entered on the CRT screen, an applications programmer may use the programmable characteristics of the function keys to provide these sequences. For example, while writing and debugging a program, the programmer may use the LIST CR command with great frequency. To lighten the burden, these commands can be programmed into function keys. Function key 1 may be defined as the List command by:

- Placing the cursor at the left margin of the CRT
- Entering the sequence of keystrokes H LIST ESC CR (H indicates that this function key will be transmitted to the host; ESC CR will store and display the CR code)
- Operating the F1 function key while holding the control key.

Subsequently operating the F1 key will cause the sequence LIST CR to be sent to the computer.

Should the programmer want to clear the screen before sending the list command, he can make a second function-key program to clear the screen and then link to the F1 key by:

- Placing the cursor at the left margin of the CRT
- Entering K ESC ESC * ESC ESC / @ (K indicates that his function operates at the terminal and is not transmitted)
- Entering CTRL SHIFT F1.

When SHIFT F1 is operated, the shifted function 1 clears the screen and then links to the unshifted F1, which sends LIST C R to the computer.

A fourth way to alter the terminal's performance is by redefining the keyboard to suit specific applications. With the ADM-42, the system designer can rearrange keycaps and assign keys different functions. Any key can do any function. For example, a foreign-language character set *can* be substituted for the standard keyboard.

Once the systems designer has decided to obtain a smart, μP-based display terminal whose characteristics may be modified, he must take care when selecting the manufacturer. The manufacturer should willingly offer three things: the terminal's source code (usually for a fee and a contract), applications-engineering support and an open line of communication with the manufacturer's design engineers. Fig. 3 shows a section of the ADM-42's source code. □

How useful?	**Circle No.**
Immediate design application	559
Within the next year	560
Not applicable	561

UPSMANSHIP. Without it, your computer could become a vegetable.

Many computers' memories are a few microseconds from oblivion. With even the briefest power outage, it's lights out for the computer, and for the people depending on the data.

But the right amount of UPSMANSHIP can get any computer through a blackout with all its marbles intact. The right amount? From 0.5 KVA to 45 KVA, depending on your needs.

The same Elgar Uninterruptible Power System (UPS) also protects your computer from life's smaller ups and downs—the momentary spikes and transients on your AC line.

To get UPSMANSHIP, get Elgar on the phone, then get Elgar on the line. 8225 Mercury Ct., San Diego, California 92111. In California, call (714) 565-1155. Out of state, call 800-854-2213 toll free.

Elgar is also a leading producer of High Isolation Transformers, AC Line Conditioners, and AC Power Sources.

ELGAR®

an Onan® power systems company

See us at NCC Booth 1856/1858.

CIRCLE NO. 76

Hellman Associates Presents a Special Tutorial Seminar

Cryptography and Data Security

Woburn, MA May 19-21 • Palo Alto, CA July 21-23
Washington, DC August 4-6 • Los Angeles, August 18-20 • Woburn, MA Sept. 29-Oct. 1

Topics

Basic Concepts • Commercial Applications
- Capabilities & Limitations of Cryptography
- Vulnerability of Communications
- Privacy Legislation

Cryptographic Systems • IBM Systems and the National Data Encryption Standard (DES)
- Public Key Cryptosystems
- Digital Signatures
- Voice Scramblers

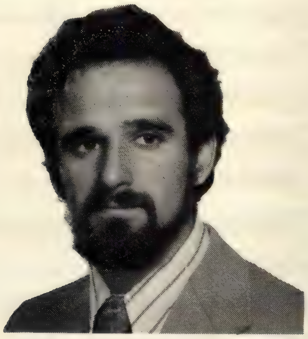
Cryptographic Theory
- Cryptanalytic Threats
- Stream and Block Systems • Trap Doors
- Shannon Theory Approach

System Implementation • Key Management
- User Authentication • Error Control
- Threat Analysis • Audit Trails
- Testing & Certification

Application Examples
- Networks & Distributed Processing
- EFTS • Electronic Mail
- Telecommunications & File Encryption

> "The code breakers may finally have met their match. As a result of recent work by Stanford University scientists, ciphers that are for all practical purposes unbreakable can be produced easily. Says **Scientific American** Mathematics Columnist Martin Gardner: 'The breakthrough bids fair to revolutionize the entire field of secret communication' . . . Hellman overcame this fundamental obstacle with a dazzlingly simple yet ingenious scheme." **[TIME MAGAZINE]**

Expertise on these vital new techniques is urgently needed by every organization that handles valuable or confidential data. Make sure that **your** organization has the expertise — reserve your place now at this intensive special seminar given by one of the world's leading experts.



MARTIN HELLMAN

Martin Hellman has earned an international reputation for his invention of the revolutionary new 'Public Key' and 'Trap Door' encryption methods. In addition, he has played a leading role in proposing improvements to the NBS Data Encryption Standard (DES). His background embodies a unique blend of research with IBM, MIT and Stanford University and extensive practical consulting experience. Dr. Hellman is also a gifted speaker, able to present complex material in an easily understood and readily applied manner. Over 500 people have attended this highly popular seminar, and enthusiastic evaluations were received from attendees with backgrounds ranging from the military to the financial world. Dr. Hellman is currently an Associate Professor of Electrical Engineering at Stanford University.

This Special Seminar is intended for managerial and technical staff working in the communications, data processing, or security area, with current or potential responsibilities for implementing, specifying, or authorizing security measures for the protection of data. A degree in engineering, science or mathematics (or equivalent background) would be useful in gaining full benefit from the more detailed technical material.

HOTEL RESERVATIONS

Washington Holiday Inn (703) 521-1600
Palo Alto Holiday Inn (415) 328-2800
Woburn Ramada Inn (617) 935-8760
Los Angeles Holiday Inn (213) 540-0500

Registration and Information Request ED5-C

Space is limited: Reserve your place now at this intensive Special Seminar.

Name: ____________________

Address: ____________________

____

____

Phone: ____________________

Return to:
Hellman Associates
299 S. California Avenue
Palo Alto, CA 94306
(415) 328-4091

☐ Please reserve space for me at the ____________ location.
☐ Check enclosed ($595).
☐ Invoice my company.

☐ Send further information about courses.
☐ Contact me about in-house presentations.

CIRCLE NO. 77

A two-card system replaces the complicated hardware formerly required to use Multibus boards with CP/M software.

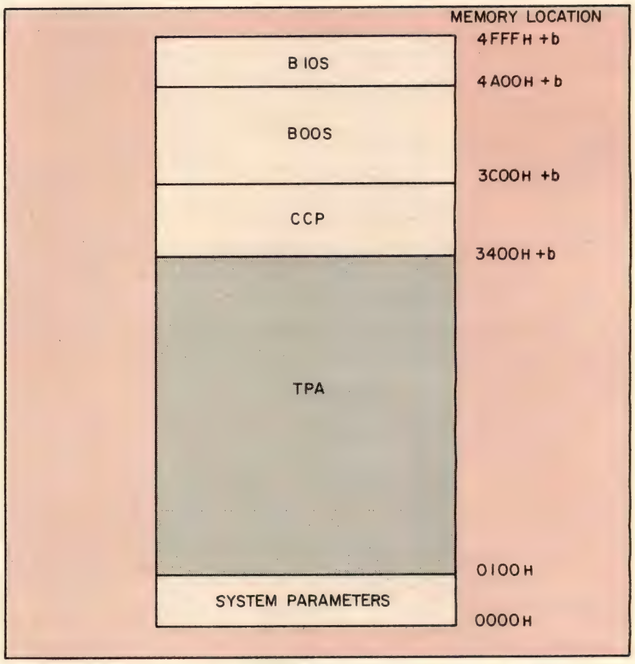
Bootstrap lets Multibus tap CP/M-based software

To assemble a microcomputer system from off-the-shelf board-level components, a designer can either evaluate dozens of hardware and software systems or choose proven performers: the CP/M disk-operating system, which offers a wealth of applications software, and Multibus boards, which offer a large selection and demonstrated reliability. Until recently, user of Multibus boards had to design a lot of intervening hardware to meet the bootstrap requirements of CP/M, which normally operates with the S-100 bus and compatible boards. Now, however, a Z80-based system from Matrox Electronics makes a CP/M Multibus system not only desirable but also feasible—it runs on just two Multibus boards under CP/M 2.0.

Why choose CP/M?

Although several good disk-operating systems exist, none can claim the popularity of CP/M, especially in aplications that need high performance. Many of the other disk-operating systems are tied, through software licenses, to one particular hardware system. Additional software (for instance, high-level programming languages) is often limited to the proprietary packages of the system vendor. Because of their low sales volume, these packages cost more than those offered for CP/M.

Low-cost CP/M can be customized to run on almost any 8080 or Z80-based hardware configuration. Its file management system uses minidisks, floppy disks or hard disks for mass storage. Programs that are created, edited, debugged, assembled and executed on one CP/M-based configuration will run on all other configurations. So, CP/M acts as a standard

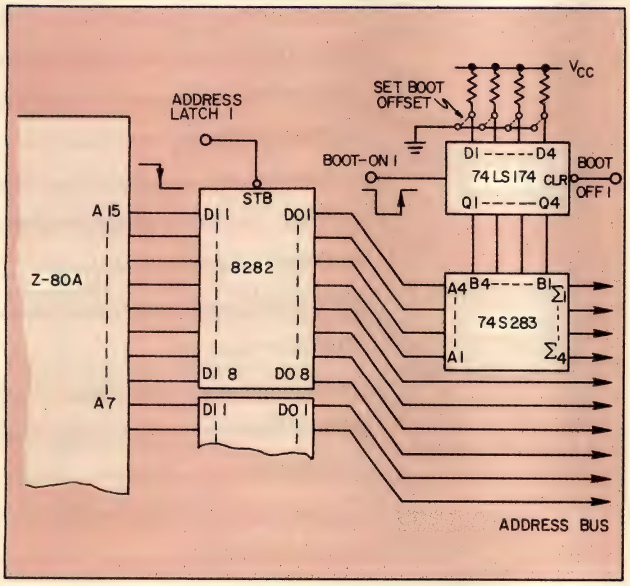


1. The memory map for a computer running CP/M 2.0 shows the major parts of the operating system: Together, the Basic I/O System (BIOS) and the Basic Disk-Operating System (BDOS) form the Floppy-Disk Operating System (FDOS). CCP is the console-command processor and TPA (gray) is the transient-program area. Its size is defined by the bias "b" and depends on the memory size of the host system. RAM must start at location 0000.

Ed Dwyer, Applications Engineer
Matrox Electronic Systems, Ltd.
5800 Andover Ave., Montréal, Quebec, H4T 1H4, Canada
Michel Lafortune, Software Engineer
Michel Bertrand, Software Engineer
École Polytechnique, Université de Montréal, Quebec, Canada

```
        ;FFD-01 PORTS
0010    COMDRG              EQU     10H         ;COMMAND REGISTER
0010    STATRG              EQU     10H         ;STATUS REGISTER
0011    TRAKRG              EQU     11H         ;TRACK REGISTER
0012    SECTRG              EQU     12H         ;SECTOR REGISTER
0013    DATARG              EQU     13H         ;DATA REGISTER
0015    RFLAG               EQU     15H         ;READ FFD FLAGS
0015    DSEL                EQU     15H         ;DRIVE SELECT PORT

        ;FD 1791-01 COMMAND CODES

0002    RESET               EQU     02          ;FIND TRACK 00
0084    RSECT               EQU     84H         ;READ SECTOR

8030    3E02                LD      A,RESET
8032    D310                OUT     COMDORG,A   ;MOVE HEAD TO TRACK 0
8034    D315      RSTEND    IN      A,RFLAG     ;WAIT UNTIL END OF
8036    OF                  RRCA                ;
8037    30FB                JR      NC,RSTEND   ;COMMAND
8039    AF                  XOR     A           ;CLEAR ACCUMULATOR
803A    67                  LD      H,A         ;LOAD HL W. START ADDR.
803B    6F                  LD      L,A         ;OF COLD-START LOADER
803C    3C                  INC     A
803D    D312                OUT     SECTRG,A    ;SET SECTOR REG. TO ONE
803F    3E84                LD      A,RSECT
8041    D310                OUT     COMDRG,A    ;SEND READ SECTOR COMMAND
8043    0680                LD      B,80H       ;B=#BYTES/SECTOR
8045    DB15      GETSCT    IN      RFLAG,A     ;WAIT UNTIL DATA REQU.
8047    CB07                RLC     A           ;ERROR IF INTERPT.
8049    F24580              JP      P,GETSCT    ;AFTER BUFFER FILLED.
804C    BD13                IN      DATARG,A    ;BYTE FROM DATA REG,
804E    77                  LD      (HL ),A     ;STORE IN MEMORY
804F    23                  INC     HL          ;INCR MEMORY POINTER
8050    10F3                DJNZ    GETSCT      ;REPEAT UNTIL WHOLE
8052    DB15      ENDCOM    IN      RFLAG,A     ;SECTOR IS READ
8054    OF                  RRCA                ;WAIT UNTIL END OF
8055    30FB                JR      NC,ENDCOM   ;COMMAND.
8057    D810                IN      STATRG,A    ;READ STATUS REG
8059    B7                  OR      A           ;SET FLAGS
805A    2007                JR      NZ,ERROR    ;ERROR IS NOT ZERO
805C    C30000              JP      0           ;JUMP TO COLD-ST. LDR.
```

2. The Matrox CP/M bootstrap loads the first sector of track 0, drive 0, into RAM at location 0000. The cold-start loader contained in this sector then brings the CP/M operating system from the first two diskette tracks into RAM and disables the ZBC-80 ROM if it overlaps external RAM.



3. The bootstrap hardware consists of three DIPs (highlighted) that interface between the Z80A and part of the address bus. The 74LS174 controls the boot and determines the offset shown in Fig. 4.

software interface between user programs and system hardware. Among high-level language packages that run with CP/M are Basic, Cobol, Fortran, APL, PL/1 and Pascal.

One of CP/M's attractions is its ability to run efficiently even in systems with as little as 20 kbytes of RAM. Large files are not stored as consecutive records but are staggered to reduce disk-latency times. CP/M is thoroughly debugged and fairly tolerant of human errors. Error checking makes it difficult to erase files inadvertently, for example.

In choosing hardware to work with CP/M, the designer has long been limited to the S-100 bus, despite the popularity of other buses (see "A Choice of Bus Routes"). The hardware for CP/M systems (supplied by such companies as Cromenco, Digital Research, Tarbell Electronics and Vector Graphics) is generally based on the S-100 bus. Many companies also offer a bootstrap based on the S-100, a cold-start loader and a customized version of CP/M's Basic I/O System (see "The Workings of CP/M").

The hardware costs of an S-100 system and a comparable Multibus system are about equal; but in performance and reliability, the Multibus system is better. For advanced systems, therefore, Multibus is as logical a choice as CP/M, but only recently have hardware and software support for a CP/M Multibus system become available.

Incompatibility poses problems

CP/M can be customized to run on almost any hardware configuration, but the system must contain at lease 20 kbytes of RAM, positioned to start at the memory address 0000H (Fig. 1). Furthermore, the hardware must include some provision to bootstrap the CP/M disk-operating system whenever a system reset occurs. In particular, the CPU must be able to fetch instructions and data from nonvolatile memory and load the CP/M "cold-start loader" into the bottom of system memory. A system designer selecting off-the-shelf-hardware for a CP/M system must be aware of these requirements.

S-100 and Multibus systems present different bootstrapping problems, both of which are solved by the technique used on Matrox's ZBC-80 single-board computer.

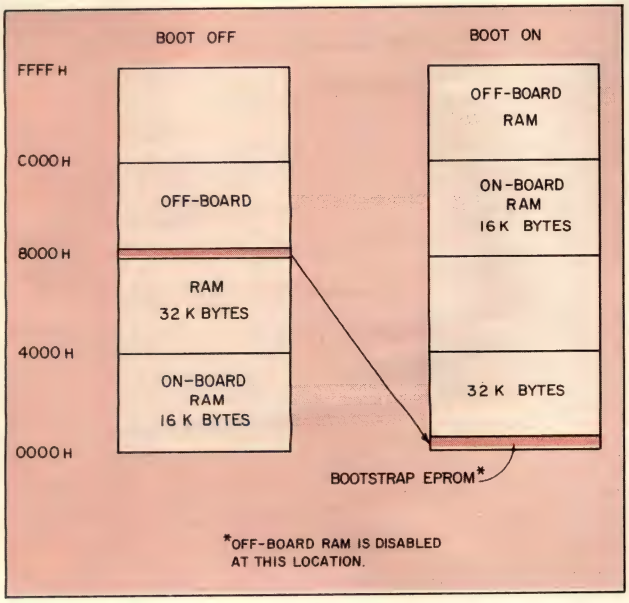
The manufacturers of Multibus-compatible cards promote the concept of a stand-alone single-board computer. The system is expanded simply by plugging additional cards into the Multibus. A typical single-board computer might contain a CPU, 8 kbytes of ROM/EPROM located between 0000H and IFFFH, 16 kbytes of RAM located above 2000H and the necessary I/O. The address of the ROM/EPROM is fixed, making it impossible to load CP/M at location 0000H as required. No provision exists to

A choice of bus routes

Many off-the-shelf products are available for the STD, S-100 and Multibus. The STD bus features small (4.5 × 6.0 in.), low-cost cards that are usually dedicated to one function only. It is primarily employed in small systems, portable microprocessor-based instruments, compact terminals and the like.

The S-100 bus uses larger cards (5.125 × 10.0 in.) that contain more circuitry than STD cards. But because the power-supply voltages on the S-100 bus are unregulated, on-board voltage regulators use up some of the extra space. Therefore, S-100 systems still tend to dedicate one card to one function (for example, one card each for CPU RAM, ROM/EPROM and I/O). The bus has another serious shortcoming: Cards from different manufacturers are often incompatible because the bus signals are not standardized. A proposed Specification for S-100 Bus Interface Devices, known as IEEE-696, should correct the situation, but will probably take years to implement.

The Multibus, designed by Intel, features a sensible layout of address, data and control signals and ample ground and power supply lines. Because of their large size, fewer Multibus cards are needed to accommodate the system hardware, improving reliability and performance. The Multibus also supports multiprocessing—up to 16 bus masters can share the system bus in a master/slave relationship. Data transfers may be byte or word oriented, for 8-bit as well as 16-bit CPUs. An existing 8-bit single-user system may be upgraded to a 16-bit multiuser system.



4. Memory allocation for a CP/M-based system is shown with and without boot offset. The offset amount is set by the circuit near the top right-hand corner of Fig. 3.

The workings of CP/M

CP/M is divided into four subsystems: the Basic Input/Output System (BIOS), the Basic Disk-Operating System (BDOS), the Console Command Processor (CCP) and the Transient Program Area (TPA). Together, the BIOS and BDOS form the Floppy-Disk Operating System (FDOS), which acts as the system hardware supervisor. The CCP interfaces the user's console to the FDOS and to information stored on disk. The TPA holds nonresident operating system commands and user programs for execution. All programs are loaded and executed at 0100H.

BIOS is a hardware-dependent module that must be written by the user to fit his hardware configuration. It contains the basic interface routines for all standard peripherals, including the floppy disk drives and user-defined peripherals. Customized BIOS (CBIOS) includes subroutines for system initialization; simple character I/O with the console, list, punch and read devices; and disk I/O. Entry into these routines is through a jump table located at the start of CBIOS.

All disk-dependent parts of CBIOS are contained in a disk-parameter block which describes the characteristics of the disk system: number of active disks, starting and ending sector numbers, sector stagger factor, checksum vector size and number of reserved tracks. The macro DISK DEF, provided with CP/M 2.0, generates these data tables and the translation vectors which map logical sector numbers into physical sector numbers.

BDOS maintains a storage map or file directory on each disk, allocates free disk space and performs calls to BIOS for basic disk operations (select disk, set track, set sector, read sector, write sector, etc.). An application program—for example, a text editor—will make use of many BDOS functions. Function calls are executed by passing the function number and address of the file control block (FCB) through the FDOS entry point. Files are identified by both file name and type and may optionally be tagged by read-only, read/write, invisible or system attributes and user numbers. CP/M features relative-record random access, which gives instantaneous (as opposed to strict sequential) access to any record in a file.

The CCP is the user's interface to the rest of CP/M. It interprets and executes two types of commands entered from the user console: built-in commands that are memory-resident and transient commands that are disk resident. Transient commands (most system routines and all utilities) fall into five categories: program entry and editing; file-handling utilities, such as copying a file from one disk to another; system utilities, such as generating and saving reconfigured versions of the operating system; program debugging tools; and high-level programming language utilities.

CCP commands are executed by typing the command mnemonic on the console. Most users interact with CP/M through the CCP only; applications software is nearly always furnished in "command" form.

bootstrap a disk operating system since none is needed for a stand-alone single-board computer.

For an S-100 bus system, the problem is the amount of hardware that bootstrapping normally entails. An S-100 system consists of a read-write memory card, a floppy disk controller (FDC), and a CPU card without bootstrap circuitry. On power-up, the program counter in the CPU is reset to 0000H and the boot-enable on the FDC is set simultaneously.

The FDC uses certain status signals on the S-100 bus to suspend the CPU's control of the data bus. It jams a short bootstrap program onto the bus, causing the CPU to load the first sector of track 00 into read/write memory starting at 0000H. A jump to the first byte of the "cold-start loader" is then executed, which resets boot-enable and brings the remaining 51 sectors of CP/M into system memory. The last instruction in the cold-start loader is a jump to the entry point of the CP/M BIOS. The FDC needs a lot of hardware to make the CPU read data from the bootstrap ROM and write data to RAM at the same address.

On to a better bus

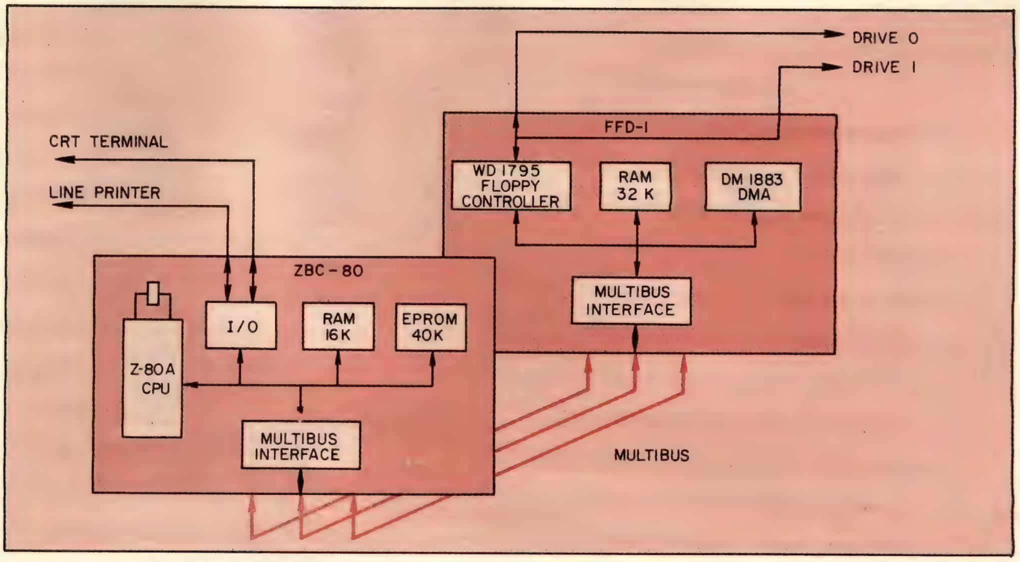
With the Matrox ZBC-80 single-board computer, the "power-on-jump logic" is placed on the CPU card itself. An EPROM at the jump address contains the bootstrap program (Fig. 2). On power-up, a reset pulse on the boot-enable line latches the boot address offset onto the B-inputs of a 74S283 4-bit binary full adder (Fig. 3). This offset is added to the 4 high-order address bits, changing the addresses of the on-board RAM and ROM/EPROM, (Fig. 4). This method is flexible and requires very little hardware to implement. Normally, the bootstrap program will use the same EPROM that is used for the system monitor. This EPROM is disabled when running CP/M.

The ZBC-80 (Fig. 5) contains a dedicated arithmetic processor, a 16-level programmable interrupt controller, bus arbitration logic and plenty of memory—16 kbytes of fast dynamic RAM and sockets for up to 40 kbytes of ROM/EPROM. Also included are six programmable parallel I/O ports, six programmable timers, a serial communications controller and an RS-232C interface. This chip set maximizes the processor's speed and efficiency.

By using a state-of-the art LSI chip-set, the FFD-1 disk controller board also packs a great deal of power onto a single card (Fig. 5). The WD-1791 or 1795 floppy-disk controller handles up to four single or double-sided 8-in. drives, and is compatible with both single and double-density recording formats. Additionally, a direct memory access controller transfers data without CPU intervention, between the disk controller and either the off-board system memory or the 32 kbytes of on-board two-port RAM.

The Matrox version of CP/M 2.0 has been tailored to run on these two cards. Users of the system benefit from the broad software support available for CP/M 2.0. Because the system is inexpensive, each programmer can work independently on his own system. Because program development takes place on the target system hardware, fewer problems crop up during software integration and program maintenance can be done in the field.□

How useful?	**Circle No.**
Immediate design application	**562**
Within the next year	**563**
Not applicable	**564**



5. This inexpensive 48-kbyte software development system, offered by Matrox, employs the Multibus-based ZBC-80 for hardware running under CP/M 2.0.

DATEL-INTERSIL

A Great Team

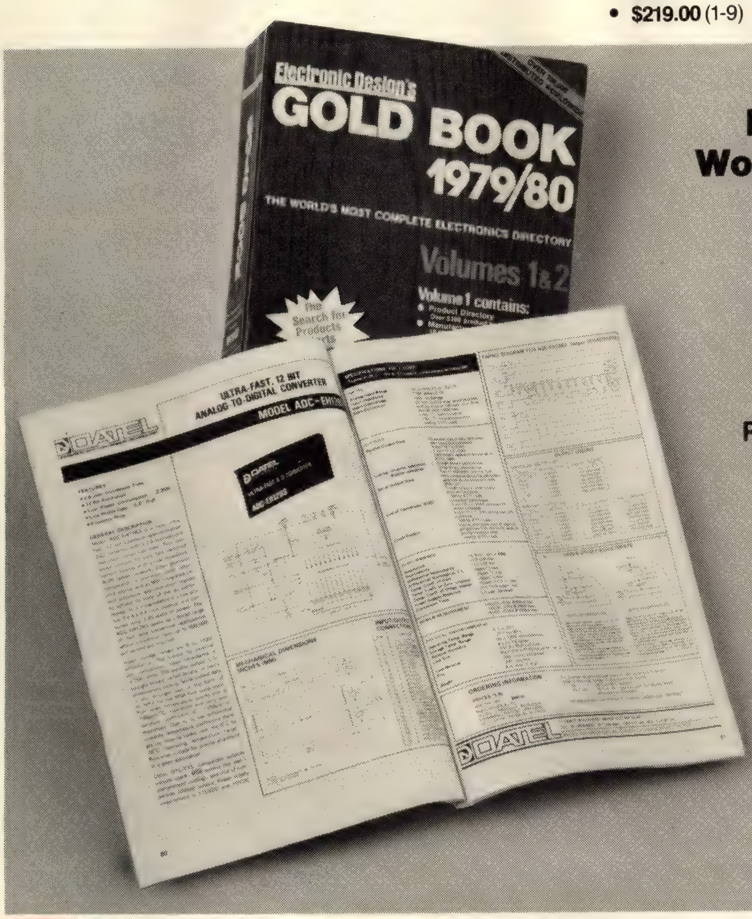
These two modules are still your best choice for fast 12 Bit data acquisition applications. Use them to sample and convert signals up to a 400 KHz rate.

SHM-5

- 350 nsec Acquisition Time (.01%)
- 5 MHz Tracking Bandwidth
- 250 p Sec Aperture Uncertainty
- 2 × 2 inch Low Profile Case
- **$219.00** (1-9)

ADC-EH12B3

- 12 Bit Resolution
- 2.0 μ Sec max Conversion Time
- ½ LSB max Linearity Error
- 2 × 4 inch Low Profile Case
- **$286.50** (1-9)


Electronic Design's
GOLD BOOK
1979/80
THE WORLD'S MOST COMPLETE ELECTRONICS DIRECTORY
Volumes 1 & 2
Volume 1 contains:
ULTRA-FAST, 12 BIT ANALOG-TO-DIGITAL CONVERTER
DATEL

Datel-Intersil and Gold Book. Working Together to Make Your Job Easier!

Together again for the 3rd year — Datel-Intersil and Electronic Design's Gold Book. Volume III of the 1979-80 Edition of Gold Book is the Datel-Intersil Engineering Product Handbook which contains complete specifications, product descriptions and application information.

So don't be delayed on your projects while waiting for product literature to arrive. Check the spec's in Gold Book today.

Electronic Design's, Gold Book the world's most complete electronics directory

DATEL INTERSIL

11 CABOT BOULEVARD, MANSFIELD, MA 02048 / TEL. (617)339-9341 / TWX 710-346-1953 / TLX 951340
Santa Ana, (714)835-2751, (L.A.) (213)933-7256 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490
• Houston, (713)781-8886 • Dallas, TX (214)241-0651 OVERSEAS: DATEL (UK) LTD—TEL: ANDOVER (0264)51055
• DATEL SYSTEMS SARL 602-57-11 • DATELEK SYSTEMS GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

CIRCLE NO. 78

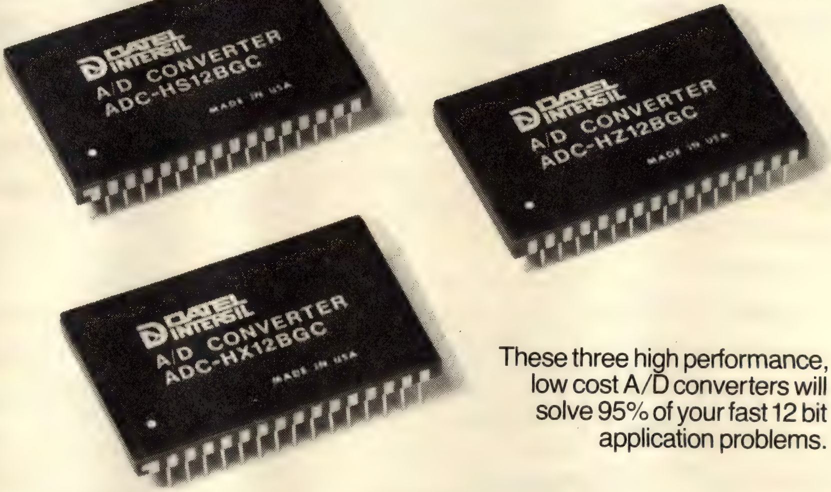
DATEL-INTERSIL

Three 12-Bit A/D Winners.

ADC-HX12BGC
12 Bits, 20 μsec.
internal input buffer

ADC-HZ12BGC
12 Bits, 8 μsec.
internal input buffer

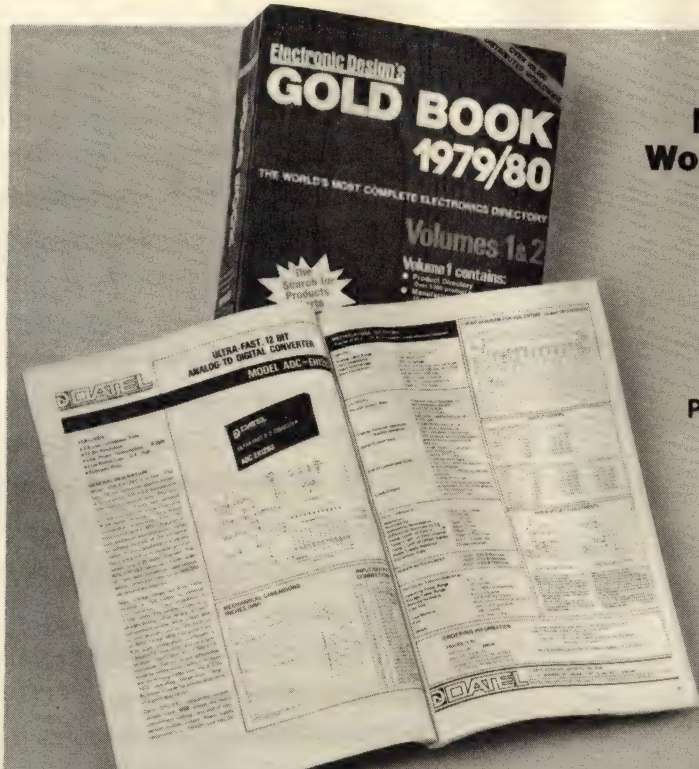
ADC-HS12BGC
12 Bits, 9 μsec.
internal sample-hold



Other Features:

- Hybrid thin-film fabrication
- ½ LSB linearity
- 5 input ranges
- 20 ppm/°C gain tempco
- 32 pin package

These three high performance, low cost A/D converters will solve 95% of your fast 12 bit application problems.


Electronic Design's
GOLD BOOK
1979/80
THE WORLD'S MOST COMPLETE ELECTRONICS DIRECTORY
Volumes 1 & 2
Volume 1 contains:
DATEL
ULTRA FAST, 12 BIT ANALOG TO DIGITAL CONVERTER
DATEL

Datel-Intersil and Gold Book. Working Together to Make Your Job Easier!

Together again for the 3rd year — Datel-Intersil and Electronic Designs Gold Book. Volume III of the 1979-80 Edition of Gold Book is the Datel-Intersil Engineering Product Handbook which contains complete specifications, product descriptions and application information.

So don't be delayed on your projects while waiting for product literature to arrive. Check the spec's in Gold Book today.

Electronic Designs, Gold Book the world's most complete electronics directory

DATEL INTERSIL

11 CABOT BOULEVARD, MANSFIELD, MA 02048 / TEL. (617)339-9341 / TWX 710-346-1953 / TLX 951340
Santa Ana, (714)835-2751, (L.A.) (213)933-7256 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490
• Houston, (713)781-8886 • Dallas, TX (214)241-0651 OVERSEAS: DATEL (UK) LTD—TEL: ANDOVER (0264)51055
• DATEL SYSTEMS SARL 602-57-11 • DATELEK SYSTEMS GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

CIRCLE NO. 79

One-piece, one side fasteners without nuts

(No wonder they're fast!)

■ Carr panel fasteners speed assembly — and hence save money — because they hold together two or more thicknesses so easily and quickly.

Newest such fastener is the two-way "Christmas tree" type, but other models in this versatile line continue to be used in countless applications. Most are designed for round holes and expand after being inserted, thereby maintaining a constant gripping force. Both permanent and removable types are available. Typical idea-sparking applications are shown below.

Face covers are secured to stereo speakers with two-way ratchet fasteners that are removable and reusable.

Cable clip has stud end that snaps into hole in panel.

Corner wire clip has "Christmas tree" stud that is pressed into hole of framework. Retaining section is flexible.

Quarter-turn fastener locks two plates firmly — and may be removed easily.

Ratchet type fasteners securing grille are applied faster than bolts and nuts and cost less.

"Hub cap" fasteners may be pressed quickly on shaft ends for retention or closure.

Accordion rivet plugs hole through which calibration adjustments are made.

Trimount fastener cuts labor cost by replacing screws for mounting motors or transformers.

Complete details on standard types in Carr's new 12-page catalog and other literature. Ask for your copies and start cutting your fastening costs. **Carr Division** of TRW Inc., 31 Ames Street, Cambridge, Mass. 02142 (617/494-5500).

TRW CARR DIVISION

PLUG IN POWER

SAVE... SPACE! POWER! MONEY!

We've got just the right product to expand your minicomputer system. The kind that'll save you Space. Power. And Money.

We have a full family of easy-to-use plug in modules to handle your input, processing and display functions. Quickly and effortlessly.

Input with our MIP-3/A. The "smart" A/D with continuous 100 KHz data acquisition that inputs from as many as 64 channels. All on one board . . . That's really saving space.

Process with our MSP-3. The "low-cost" array processor with an extensive array library that's 20 to 50 times faster than your mini. Needs only 10 AMPS @ 5V. That's really saving power.

Display the MDP-3 way. A raster display processor for exceptionally high performance color imaging. With built in features like zoom and interpolation. That's really giving you more for your dollar.

Sheer PLUG-IN POWER. From Computer Design & Applications . . . a recognized leader in multiprocessing. Call or Write today for details on our complete family of analog and digital products.

cda

COMPUTER DESIGN & APPLICATIONS, INC.
377 Elliot Street / Newton, MA 02164 (617) 964-4320

CIRCLE NO. 81

Nine-branch ladder networks with complex elements yield to a calculator program based on a matrix method. The program lets the TI-59 handle a task once reserved for large computers.

TI-59 calculator analyzes complex ladder networks

Engineers who do not have access to large computers need only a TI-59 programmable calculator to analyze up to nine-branch ladder networks containing complex elements. The value of the TI-59 becomes particularly apparent in investigating the effects of component tolerances on filter performance. The savings in component costs and design time on one project alone will often cover the entire cost of the calculator and its use.

Each branch of the ladder (Y_r, Z_r) may consist of a series or parallel connection of two basic elements: a resistance in series with an inductance or a conductance in parallel with a capacitance (Fig. 1). The ladder-analysis program (Table 1) is based on a matrix method, which provides selected solutions and a printout of the answers, depending on the program options the user selects (see Fig. 2):

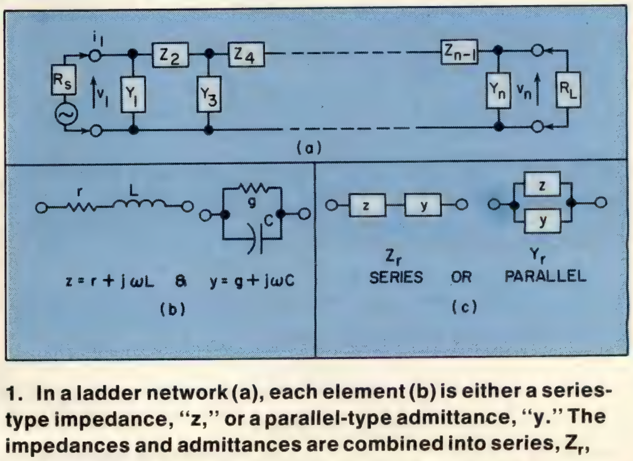
- Transfer impedance (modulus and argument) and insertion loss in dB
- Input impedance (modulus and argument) and voltage transfer ratio with respect to the source
- Group delay in incremental form.

The analysis can be for a single frequency or for a series of frequencies that the program automatically selects between given start and stop points. Frequency step size can be varied to "zoom-in" on selected sectors of the response or to make the program's incremental calculation of group delay approach more closely to the true derivative values.

The program's design simplifies data entry to reduce errors. Most errors occur during the data-entry phase of the calculation. Entries made in units of ohms (including the conductance), μH, pF and MHz are best for high-frequency filter design. Merely changing captions, however, allows other combinations, such as mH, nF and kHz, or H, μF and Hz, to be used for intermediate and low-frequency situations. Group-delay answers appear in ns, μs or ms, respectively, for these unit groups. These unit combinations avoid much key pressing and the programming problems that other engineering formats would present when printing captions.

Each component entry is printed out with a caption, which helps check errors and improve record keeping. Null components (elements absent in a branch) are not entered except to erase errors. This procedure eliminates any confusion over whether to enter a short or open circuit for a null element. The only decision necessary during data entry is whether or not the two basic elements are in series. Output results, like entries, are printed out with protected captions; therefore, a fixed-decimal format may be selected for running the program.

Program running time depends on the number of branches: five branches take about one minute per frequency; nine take two minutes. The calculator's memory limits the program to nine branches. Although branch configurations generally are limited to one L or C each (circumventable sometimes with dummy branches), the usual forms of Butterworth, Chebyshev and Cauer (elliptic) filters still are within



1. In a ladder network (a), each element (b) is either a series-type impedance, "z," or a parallel-type admittance, "y." The impedances and admittances are combined into series, Z_r, and parallel, Y_r, branches (c) to make up the network.

C.J. McCluskey, Chief Engineer
R. Travis, Project Engineer
Spilsbury Communications Systems
120 E. Cordova St., Vancouver, B.C. Canada V6G 1L1

the program's capability. A five-stage Chebyshev bandpass filter (Fig. 2) is easily handled by the program, following the instructions in Table 2.

The matrix solutions provided by the program are calculated from the following equations:

Transfer impedance $Z_t = v_n/i_s = (\det_n x)^{-1}$

Input impedance $Z_i = v_1/i_1 = (\det_n x/\det_{n-1} x - G_S)^{-1}$

Insertion loss (dB) $I.L = \text{mod } 10 \text{ Log } (4 \mid Z_t \mid^2 G_S \ G_L)$

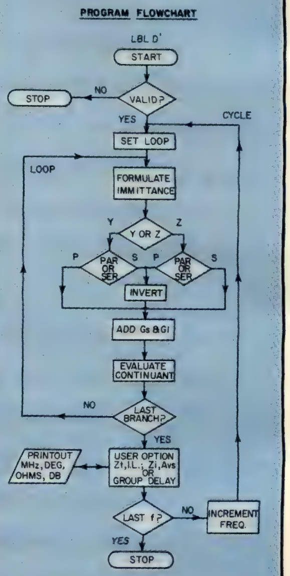
Voltage transfer $A_{vs} = \mid v_n/v_s \mid = \mid Z_t \mid G_S$

Group delay (ns) $-d\phi/d\omega \cong -(\Delta\phi/\Delta f)/0.36$,

where ϕ is $\angle Z_t$ in degrees, f is in MHz, $\det_n x$ is the determinant,

Table 1. TI-59 PROGRAM FOR LADDER NETWORK

Step No.	Keys	Comments
000-017	0 R/S LBL A′ CLR INV FIX 5 OP 17 CMS 6 OP 17 0 STO 50 RST	Stop initialize
018-043	LBL A X⇆T RCL 07 X⇆T INV GE 00 30 STO 07 STO 09 x 4 + 1 1) STO 08 RCL 09 PRT R/S	Enter Br # save max #
044-056	LBL B STO 09 X⇆T RCL 53 OP 04 3 GTO 01 16	Enter r Ω
057-076	LBL C STO 09 x 2 x π) X⇆T 4 1 2 3 OP 04 2 GTO 01 16	Enter L μH
077-094	LBL D STO 09 CP EQ 00 86 1/X X⇆T RCL 53 OP 04 1 GTO 01 16	Enter R Ω (for G)
095-115	LBL E STO 09 x 2 x π ÷ 6 INV LOG) X⇆T 3 3 2 1 OP 04 0	Enter C pF
116-129	+ RCL 08) STO 10 X⇆T ST* 10 RCL 09 OP 06 RST	Store data Prt w caps
130-146	LBL E′ SBR 01 47 SBR 01 47 OP 00 RCL 55 OP 04 OP 05 RST	Enter ser's Prt SER's
147-165	RC* 08 +/− OP 28 OP 28 EX* 08 +/− OP 38 OP 38 ST* 08 OP 28 RTN	Exchange & sign ser's
166-188	LBL B′ 1/X STO 58 RCL 53 OP 04 RCL 58 1/X ADV OP 06 R/S 1/X STO 59 1/X OP 06 RST	Enter R_s, R_L
189-199	LBL C′ STO 06 STO 57 0 R/S STO 57 RST	Enter f_1, f_2
200-211	RC* 08 OP 38 CP GE 02 11 +/− STF 01 RTN	Recall data
212-218	÷ 2) INV INT CP RTN	Odd or even?
219-231	STO 09 OP 20 RC* 00 OP 04 RCL 09 OP 06 RTN	Printout
232-245	LBL D′ STO 05 RCL 07 SBR 02 12 EQ 00 17 STF 02	Enter df Max # odd?
246-257	RCL 07 STO 00 x 4 + 1 4) STO 08	Set mem ctr
258-271	1 STO 13 0 STO 09 STO 10 STO 11 STO 12 STO 14	Initialize det x stack
272-306	SBR 02 00 STO 01 SBR 02 00 x RCL 06) STO 02 PGM 05 E CE SBR 02 00 STO 03 SBR 02 00 x RCL 06) STO 04 PGM 04 B	Calculate Y or Z
307-325	RCL 00 SBR 02 12 EQ 03 16 INV IFF 01 03 24 PGM 05 E CE INV STF 01	Y or Z? Ser or par?
327-348	RCL 00 X⇆T 1 INV EQ 03 39 RCL 58 SUM 01 RCL 07 INV EQ 03 49 RCL 59 SUM 01	Add G_S, add G_L
349-360	RCL 13 EXC 11 STO 09 RCL 14 EXC 12 STO 10	Push stack
361-397	RCL 01 PRD 13 PRD 14 RCL 02 +/− x RCL 12 STO 04 + RCL 09) SUM 13 RCL 02 x RCL 11 STO 03 + RCL 10) SUM 14 DSZ 00 02 72	Evaluate det x & loop
398-424	RCL 13 STO 01 RCL 14 STO 02 ADV SBR 04 25 RCL 57 X⇆T RCL 06 GE 00 17 RCL 05 SUM 06 GTO 02 46	Calculate response +df & cycle
	OPTION 1: Transfer Impedance and Insertion Loss	
425-469	5 0 STO 00 RCL 06 SBR 02 19 RCL 13 X⇆T RCL 14 INV P/R +/− SBR 02 19 X⇆T 1/X SBR 02 19 x^2 x 4 x RCL 58 x RCL 59) LOG x 1 0) |x| SBR 02 19 RTN	Prt f MHZ $\angle Z_t$ DEG $\lvert Z_t \rvert$ OHMS I.L. DB
	OPTION 2: Input Impedance and Voltage-Transfer Ratio	
425-477	5 0 STO 00 RCL 06 SBR 02 19 PGM 04 C′ CE — RCL 58) X⇆T RCL 02 INV P/R +/− SBR 02 19 X⇆T 1/X SBR 02 19 RCL 13 X⇆T RCL 14 INV P/R X⇆T 1/X x RCL 58) LOG x 2 0) SBR 02 19 RTN	Prt f MHZ $\angle Z_i$ DEG $\lvert Z_i \rvert$ OHMS Avs DB
	OPTION 3: Group Delay	
425-478	5 0 STO 00 IFF 02 04 27 RCL 06 — RCL 05 ÷ 2) SBR 02 19 4 SUM 00 RCL 13 X⇆T RCL 14 INV P/R +/− — EXC 54) IFF 02 04 75 ÷ • 3 6 ÷ RCL 05) |x| SBR 02 19 INV STF 02 RTN	Prt mean f MHZ Grp delay NS



*Program uses Complex-Number program from Master-Library Module.

$$\begin{vmatrix} Y_1+G_s & +1 & 0 & 0 & & & & \\ -1 & Z_2 & +1 & 0 & & & & \\ 0 & -1 & Y_3 & +1 & \ldots \text{etc} \ldots & -1 & Z_{n-1} & +1 \\ & & & & & 0 & -1 & Y_n+G_L \end{vmatrix},$$

and determinant $\det_{n-1}x$ is the minor of Y_1+G_S.

This form of tridiagonal determinant is called a continuant, from the theory of continued fractions. It is evaluated by a recursive procedure that requires a memory stack of just six locations (09-14); consequently, most of the memory space remains available for data storage.

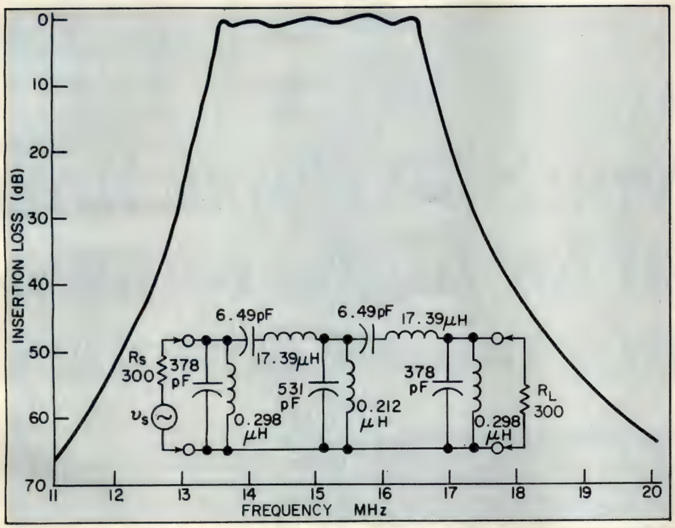
The program flowchart and program listing (Table 1) will clarify the program's procedure.□

How useful?	**Circle No.**
Immediate design application	**565**
Within the next year	**566**
Not applicable	**567**

Table 2. Ladder-network program instructions

Load caption memory					
9900302346	STO 51	MHZ	9900001614	STO 54	DB
9900161722	STO 52	DEG	3617356536	STO 55	SER'S
9932233036	STO 53	OHMS	9900003136	STO 56	NS

Key in program with one option and load captions.
Initialize, press A'.
Enter branch number, press A.
Enter branch (r Ω, L μH), (RΩ, C pF); press B,C,D,E, respectively.
Do not enter null components.
If (r,L) and (R,C) are in series, press E'.
Repeat for all branches. Maximum number must be odd.
To edit, first enter branch number and four zeros to erase.
Enter source resistance, press B'; load resistance; press R/S.
Enter start frequency, press C'; stop frequency, press R/S.
Enter step frequency; set fix decimal format; press D'.
Program runs and prints out results automatically.
For single frequency, omit stop frequency and enter zero as step frequency. (Enter f; press C'; display 0; press D'.)
To record two options, store banks 1 and 3 on one magnetic card and two bank 2s on the second card.



```
Keys   Entries
A'
A           1.
C       0.298           UH
E        378.           PF
A           2.
C       17.39           UH
E        6.49           PF
E'                   SER'S
A           3.
C       0.212           UH
E        531.           PF
A           4.
C       17.39           UH
E        6.49           PF
E'                   SER'S
A           5.
C       0.298           UH
E        378.           PF
B'       300.         OHMS
R/S      300.         OHMS
11    C'           f1
20    R/S          f2
 1    2nd fix 1        D'  df
```

```
     Group delay
  11.5          MHZ
  22.6           NS

  12.5          MHZ
  60.1           NS

  13.5          MHZ
 625.1           NS

  14.5          MHZ
 506.1           NS

  15.5          MHZ
 462.9           NS

  16.5          MHZ
 381.8           NS

  17.5          MHZ
  76.3           NS

  18.5          MHZ
  25.0           NS

  13.5          MHZ
  13.4           NS
```

Example: 5-stage Chebyshev bandpass; f_0 = 15 MHz

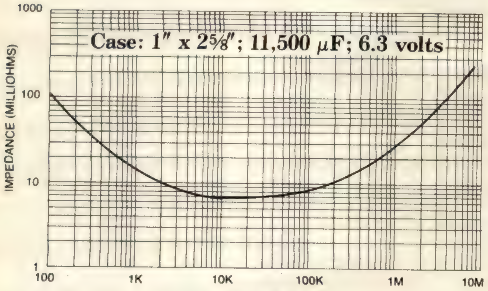
```
Transfer impedance      Input impedance
  11.0         MHZ      11.0          MHZ
  72.3         DEG      90.0          DEG
   0.1        OHMS      46.7         OHMS
  66.9          DB      72.9           DB

  12.0         MHZ      12.0          MHZ
  64.2         DEG      90.0          DEG
   0.4        OHMS      68.7         OHMS
  51.0          DB      57.1           DB

  13.0         MHZ      13.0          MHZ
  42.6         DEG      89.9          DEG
   6.6        OHMS     131.8         OHMS
  27.2          DB      33.2           DB

  14.0         MHZ      14.0          MHZ
-182.5         DEG      30.6          DEG
 144.3        OHMS     306.7         OHMS
   0.3          DB       6.4           DB

  15.0         MHZ      15.0          MHZ
  -0.3         DEG       2.5          DEG
 150.0        OHMS     300.1         OHMS
   0.0          DB      -6.0           DB

  16.0         MHZ      16.0          MHZ
 166.9         DEG     -23.7          DEG
 146.5        OHMS     329.3         OHMS
   0.2          DB       6.2           DB

  17.0         MHZ      17.0          MHZ
  29.5         DEG     -89.6          DEG
  17.2        OHMS     175.0         OHMS
  18.8          DB     -24.8           DB

  18.0         MHZ      18.0          MHZ
  57.0         DEG      90.0          DEG
   1.3        OHMS      89.0         OHMS
  41.0          DB      47.0           DB

  19.0         MHZ      19.0          MHZ
  66.0         DEG      90.0          DEG
   0.3        OHMS      63.8         OHMS
  54.0          DB      60.1           DB

  20.0         MHZ      20.0          MHZ
  70.8         DEG      90.0          DEG
   0.1        OHMS      50.7         OHMS
  63.5          DB      69.5           DB
```

2. The response of a five-stage Chebyshev bandpass filter (a), centering about 15 MHz, is an example of a complex ladder network that the program can handle. Printouts of the data entries and the three solution options for the filter (b) show the simplicity and the clarity with which the data are presented.

New Sangamo Type 350 Capacitors: The new standard for high-frequency switching regulator power supplies!

Now you can design the next generation of high-frequency regulator switching supplies. The components are here now!

New low-inductance Sangamo Type 350 Premium-Grade Aluminum Electrolytic Capacitors are perfect for critical circuit designs in high-frequency applications from 20 up to 400 kHz.



Unique (patent pending) internal construction features terminal tabs with fully interactive electromagnetic fields to minimize ESL.

Type 350 capacitors are easy to install in your printed circuit boards. Three radial leads are arranged in an isosceles triangle, so you can just plug in and wave-solder. You can't install them backwards.

In high ripple current applications, operate them in parallel with equal current sharing.

Save installation space and cost. Get economical, low-inductance, Sangamo Type 350 Aluminum Electrolytic Capacitors in your high-frequency switch mode power supplies now!

Type 350 Capacitors Electrical/Mechanical Specifications

Capacitance Range	90 μF to 15,500 μF
ESR Values at 20 kHz	From .011 ohms
Impedance Value at 200 kHz	From .014 ohms
Typical Inductance	5 to 6 nanohenries
Max. Ripple Current Capability at 20 kHz*	13.3 amps at 65°C; 9.7 amps at 85°C
Operating Temperature Range	−55°C to +105°C
Voltages Available	3.0 to 100 vdc
Nominal Case Sizes	.750″ x 1.125″ (19.05 mm x 28.58 mm) to 1.000″ x 2.625″ (25.40 mm x 66.68 mm)

*For high ripple current applications, units may be installed in parallel.

Write for specs and engineering samples. Sangamo Capacitor Division, Box 128, Pickens, SC 29671; phone: (803) 878-6311; TWX: 810-397-2496; Telex: 57-0441.

SANGAMO WESTON
Schlumberger

CIRCLE NO. 82

Touch-Tone® detection in reliable, low-cost MOS-LSI.

The Rockwell CRC-8030 dual tone multi-frequency (DTMF) detector helps make telecommunications faster, more efficient and more convenient.

Micro power

Rockwell International made the first MOS-LSI Touch-Tone® detector. And after four years of production experience and over 800,000 devices in operation around the world, the CRC-8030 is the low-cost, high performance leader in DTMF detection. That's Rockwell Micropower!

The CRC-8030 can reduce the cost of Touch-Tone® detection by as much as 80%. It is smaller, more reliable and requires fewer adjustments than non-MOS-LSI devices. Its superior performance in recognition of digits and "talk-off" make it the choice of telecommunications engineers.

In addition to its traditional telephone applications, the CRC-8030 is applied to a widening array of data transmission, signaling, control system and other non-telephony situations.

A result of Rockwell high technology telecommunications experience, the CRC-8030 features: detection in 22-39 MS; on-chip oscillator operating at 3.579545 MHz color burst crystal frequency; binary or 2-of-8 coded outputs; operation with single or dual power supply.

The CRC-8030 performs the key critical functions of DTMF detection. To implement a complete DTMF receiver, a number of front-end band-split filters are available.

For more information, contact Telecom Marketing, Electronic Devices Division, Rockwell International, P.O. Box 3669, RC55, Anaheim, CA 92803. Or call (714) 632-3729.

Touch Tone is a registered trademark of AT & T.

Rockwell International

...where science gets down to business

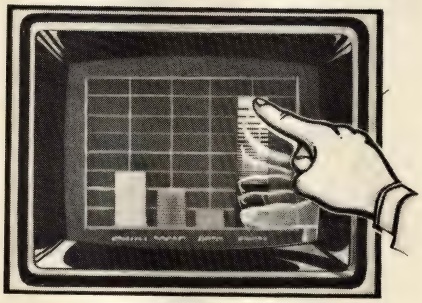
CIRCLE NO. 83

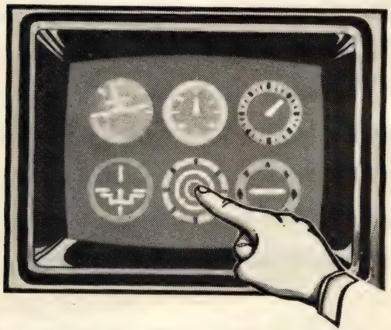
TRANSFLEX™

the membrane switch that lets your imagination show through.

TransFlex is the new membrane switch clear enough to read through. Brings people and computers closer together. And that's just the beginning...

As easy as touching a picture, graph, word or letter. TransFlex activates the desired response.





For analog or XY matrix panels. TransFlex membrane switches utilize our highly linear Intrex® films, solving your most critical resistivity requirements.

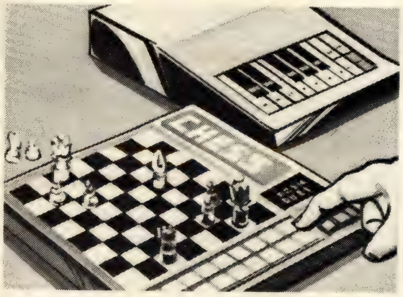
Fully conductive. TransFlex's transparent conductors do not interfere with the display. Image and readability are actually enhanced.

Can be designed to your specifications for size, resistivity, light transmission...and to control any graphic pattern.

Can be formed to the contour of your CRT screens or control panels.

Can be sealed for cleaning and weatherproof versatility.

Can be backlighted for many uses we know about...and many more you can think of.



Learn more about TransFlex.
Contact: Sierracin Corp.,
12780 San Fernando Rd.,
Sylmar, CA 91342,
Phone (213) 367-6184 or 362-3134.

Sierracin

CIRCLE NO. 84

A fast-Fourier-transform program—adapted from the Cooley-Tukey algorithm—runs on a TI-59 programmable calculator.

Calculator program speeds through 32 FFT points

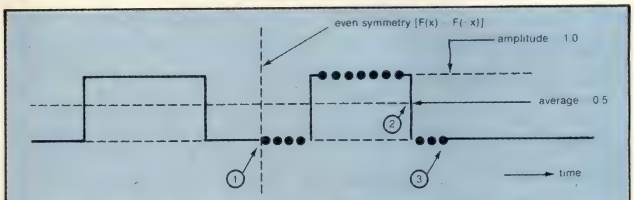
Fourier transforms can be performed on up to 32 points of real or complex data with a TI-59 programmable calculator, using a program based on a compact Fortran version of the Cooley-Tukey (C-T) fast-Fourier-transform (FFT) algorithm.[1,2]

The program (Table 1) is over four times faster than Texas Instruments' EE-17 program, contained in its electrical-engineering module. Although both programs handle complex inverse-transform inputs (frequency to time), the EE-17 handles only real forward time data (albeit for 88 points); the C-T program can handle both complex and real forward-transform (time-to-frequency domain) data. Such transform calculations are essential in analog and digital signal processing, filter-response analysis and antenna-pattern calculations, among many other applications.

The program requires almost all the 100 data registers in the TI-59. One reason is that each data point in the C-T algorithm consists of two entries, a real followed by a complex value. As a result, the 32 data points require 64 registers alone for storage. (Incidentally, the algorithm requires that the number of data points be integral powers of 2, so 32 points is the maximum the TI-59 can handle.)

In addition, the program needs almost all the remaining data registers plus all the partitioned program steps. With the TI-59 partitioning set at 319.79 (by instruction 8 OP-17 for 320 program steps and 80 data registers), the 16 registers not used for data are needed to store program parameters, indices and computed intermediate values (scratch storage). The 320 program steps are all used.

Fortunately, the C-T algorithm saves memory space by storing its outputs in the same memory locations as the input data—this technique is called "in-place calculation," an important feature of the algorithm. As each output step ends, its results end



For a 16-point input, key-in data for one cycle:
2nd, CMs, 4, A; followed by

0 R/S	0 R/S	0 R/S	0 R/S	0 R/S	0 R/S	0 R/S	0 R/S	0.5 R/S	0 R/S
1 R/S	0 R/S	1 R/S	0 R/S	1 R/S	0 R/S	1 R/S	0 R/S	1 R/S	0 R/S
1 R/S	0 R/S	1 R/S	0 R/S	0.5 R/S	0 R/S				

which covers 13 points ① through ②. The three remaining points to ③ are all zeroes and neet not be entered explicitly.

Frequency spectrum output

```
               8 .           I 0   ┐
               0 .           Q 0   ┘— I0/N = 8/16 = 0.5
 - 5 . 0 2 7 3 0 9 4 9 2     I 1R       (average)
             2 . 2 - 1 2     Q 1R
               0 .           I 2R
               0 .           Q 2R
   1 . 4 9 6 6 0 5 7 6 3     I 3R
           - 3 . 9 - 1 2     Q 3R
               0 .           I 4R
               0 .           Q 4R
 - . 6 6 8 1 7 8 6 3 7 9     I 5R
             2 . 3 - 1 2     Q 5R
               0 .           I 6R
               0 .           Q 6R
   . 1 9 8 9 1 2 3 6 7 4     I 7R
             3 . 1 - 1 2     Q 7R
               0 .           I 8R , I 8L
- - - - - - - - - - - - - - - - - - - - -
               0 .           Q 8R , Q 8L
   . 1 9 8 9 1 2 3 6 7 4     I 7L
           - 3 . 6 - 1 2     Q 7L
               0 .           I 6L
               0 .           Q 6L
 - . 6 6 8 1 7 8 6 3 7 9     I 5L
             - 3 . - 1 3     Q 5L
               0 .           I 4L
               0 .           Q 4L
   1 . 4 9 6 6 0 5 7 6 3     I 3L
             - 9 . - 1 3     Q 3L
               0 .           I 2L
               0 .           Q 2L
 - 5 . 0 2 7 3 3 9 4 9 2     I 1L
             1 . 1 - 1 2     Q 1L
```

Divide by 16 to normalize.

A square wave is a convenient program test function. Time-to-frequency transformations result in odd harmonics only, and the zero-frequency component is the wave's average amplitude. Since the input data are real, all quad-phase components are zero.

Robert E. Harrison, Consultant
27978 Beechgate Rancho, Palos Verdes, CA 90274

up back in the registers that held the original input data. As a result, the 64 data registers are sufficient for 32 points.

Input (and then the output) data of the transform's spectral components occupy registers R_{05} through R_{68} for a full 32-point transform. Fewer inputs, of course, occupy fewer registers $R_{05} + 2N-1$, where N = number of points), starting with R_{05} (see table 2). Parameters are stored in registers R_{00}, and R_{69} through R_{79}; R_{01} through R_{04} are reserved for the TI-59's master-library program, ML-04.

Components designated $\pm I_{md}$ in Table 2 are the in-phase parts of the data; those designated $\pm Q_{md}$ are the quadrature-phase parts. The subscript "m" designates the "pitch" of the phasor that represents the data—the *number* of revolutions the phasor makes over the "length" of the data, or data frame. The subscript "d" designates the "direction" of rotation —left (L) or right (R), when "looking" from the first to the last *point*. The user must establish which direction is the positive (or negative) frequency, depending on the direction of phase progression in the data.

Components I_o and Q_o supply the zero frequency (dc) or average component. All transformed values must be normalized by dividing by N. When real data are transformed, the result is a set of two oppositely rotating phasors whose signs are the same when the symmetry at the origin is even (see the figure) and opposite when odd.

The program has two independent parts: a data permutation known as bit-reversed shuffling (Table 3) and a recorded-data transformation done with the C-T algorithm (Table 4). The initial data reordering compensates for the data shuffling that occurs in the transformation. (The index of a transformed spectral component comes out in reverse order.) All this reordering takes almost 1 minute for 32 points.

The transformation part employs three major loops (Table 2). One of them, a recursion relationship, generates the values of sine and cosine kernels. (Direct computation of the sines and cosines occurs only when the argument of the kernel is being incremented. For details of the functions of the other loops, refer to references 1 and 2.)

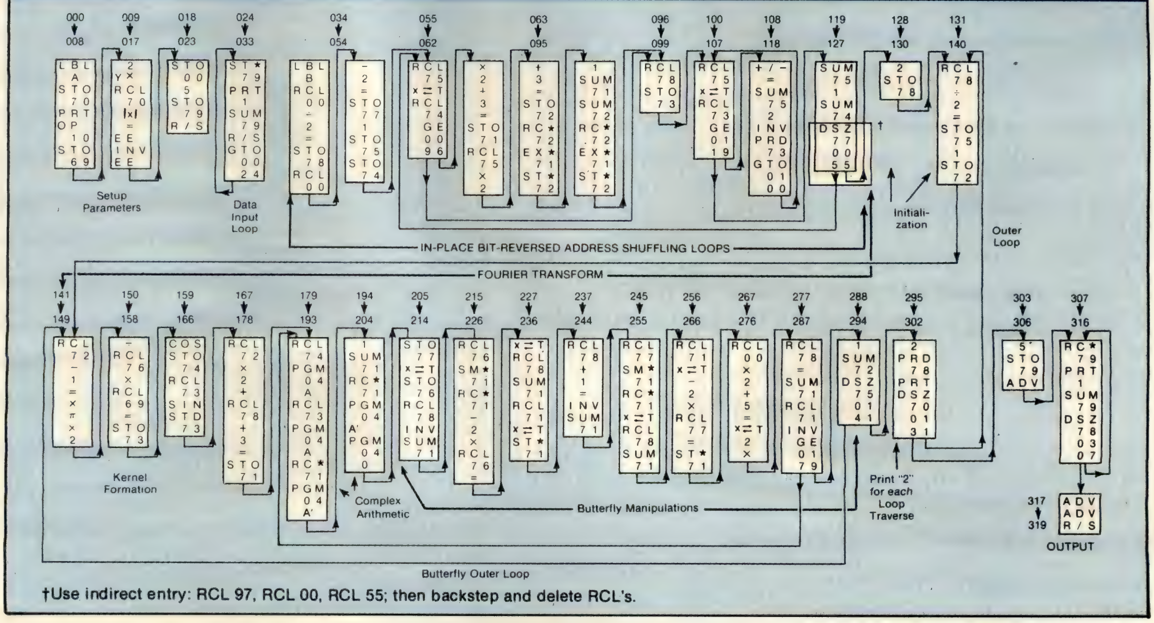
Load data in special sequence

Data from the keyboard must be introduced in a special place in the operating procedure, and, for a 32-point case, the program and data must be loaded in a particular order. Data are introduced before pressing B (Table 2):

- Key in the value ±M, where the number of points, N, equals 2^M. The sign of M is positive for forward time-to-frequency transforms and negative for inverse transforms.
- Press A. The value of M is printed (if a printer is used), and the calculator stops at step 023 and displays a 5.
- Key in data manually, starting with the real part of point 1, R/S, followed by the imaginary part of point 1, R/S, the real part of point 2, R/S, the imaginary part of point 2, R/S, etc. *(Data also can be entered from a specially prepared magnetic card.)*
- Check the data-register content with the RCL key, correct them with STO, and list them (on the printer) with instruction 5 INV 2ND LIST.

Once the data are verified, press B. During the

Table 1. C-T-based Program for Fourier Transforms



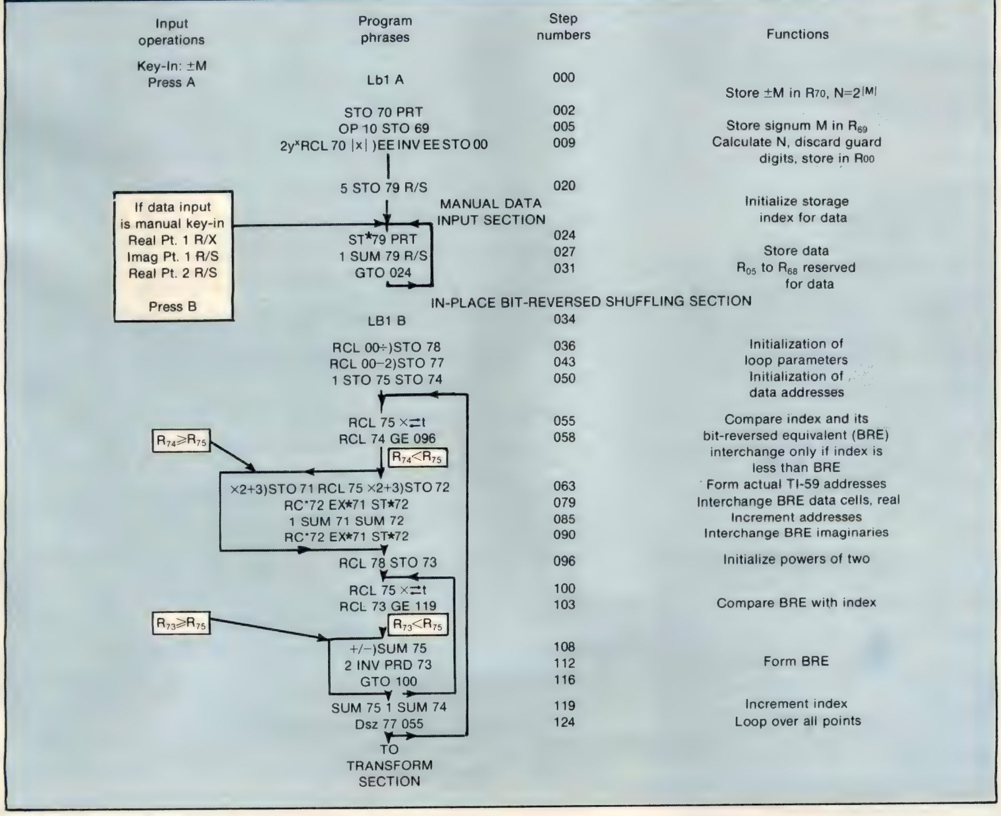
```
000-008
LBL
A
STO
70
PRT
OP
10
STO
69

009-017
2
Y×
RCL
70
|x|
=
EE
INV
EE

018-023
STO
00
5
STO
79
R/S

024-033
ST*
79
PRT
1
SUM
79
R/S
GTO
00
24

034-054
LBL
B
RCL
00
÷
2
=
STO
78
RCL
00

−
2
=
STO
77
1
STO
75
STO
74

055-062
RCL
75
x⇄T
RCL
74
GE
00
96

063-095
×
2
+
3
=
STO
71
RCL
75
×
2

+
3
=
STO
72
RC*
72
EX*
71
ST*
72

1
SUM
71
SUM
72
RC*
.72
EX*
71
ST*
72

096-099
RCL
78
STO
73

100-107
RCL
75
x⇄T
RCL
73
GE
01
19

108-118
+/−
=
SUM
75
2
INV
PRD
73
GTO
01
00

119-127
SUM
75
1
SUM
74
DSZ
77
00
55 †

128-130
2
STO
78

131-140
RCL
78
÷
2
=
STO
75
1
STO
72

141-149
RCL
72
−
1
=
×
π
×
2

150-158
÷
RCL
76
×
RCL
69
=
STO
73

159-166
COS
STO
74
RCL
73
SIN
STD
73

167-178
RCL
72
×
2
+
RCL
78
+
3
=
STO
71

179-193
RCL
74
PGM
04
A
RCL
73
PGM
04
A
RC*
71
PGM
04
A'

194-204
1
SUM
71
RC*
71
PGM
04
A'
PGM
04
0

205-214
STO
77
x⇄T
STO
76
RCL
78
INV
SUM
71

215-226
RCL
76
SM*
71
RC*
71
−
2
×
RCL
76
=

227-236
x⇄T
RCL
78
SUM
71
RCL
71
x⇄T
ST*
71

237-244
RCL
78
+
1
=
INV
SUM
71

245-255
RCL
77
SM*
71
RC*
71
x⇄T
RCL
78
SUM
71

256-266
RCL
71
x⇄T
−
2
×
RCL
77
=
ST*
71

267-276
RCL
00
×
2
+
5
=
x⇄T
2
×

277-287
RCL
78
=
SUM
71
RCL
71
INV
GE
01
79

288-294
1
SUM
72
DSZ
75
01
41

295-302
2
PRD
78
PRT
DSZ
70
01
31

303-306
5
STO
79
ADV

307-316
RC*
79
PRT
1
SUM
79
DSZ
78
03
07

317-319
ADV
ADV
R/S
```

†Use indirect entry: RCL 97, RCL 00, RCL 55; then backstep and delete RCL's.

Table 2. Register Map for The Program Output

8-Point		16-Point		32-Point			
Data Register Number	Spectral Component	Data Register Number	Spectral Component	Data Register Number	Spectral Component	Data Register Number	Spectral Component
5	$\pm I_0$	5	$\pm I_0$	5	$\pm I_0$	39	$\pm I_{15L}$
6	$\pm Q_0$	6	$\pm Q_0$	6	$\pm Q_0$	40	$\pm Q_{15L}$
7	$\pm I_{1R}$	7	$\pm I_{1R}$	7	$\pm I_{1R}$	41	$\pm I_{14L}$
8	$\pm Q_{1R}$	8	$\pm Q_{1R}$	8	$\pm Q_{1R}$	42	$\pm Q_{14L}$
9	$\pm I_{2R}$	9	$\pm I_{2R}$	9	$\pm I_{2R}$	43	$\pm I_{13L}$
10	$\pm Q_{2R}$	10	$\pm Q_{2R}$	10	$\pm Q_{2R}$	44	$\pm Q_{13L}$
11	$\pm I_{3R}$	11	$\pm I_{3R}$	11	$\pm I_{3R}$	45	$\pm I_{12L}$
12	$\pm Q_{3R}$	12	$\pm Q_{3R}$	12	$\pm Q_{3R}$	46	$\pm Q_{12L}$
13	$\pm I_{4R}$, $\pm I_{4L}$	13	$\pm I_{4R}$	13	$\pm I_{4R}$	47	$\pm I_{11L}$
14	$\pm Q_{4R}$, $\pm Q_{4L}$	14	$\pm Q_{4R}$	14	$\pm Q_{4R}$	48	$\pm Q_{11L}$
15	$\pm I_{3L}$	15	$\pm I_{5R}$	15	$\pm I_{5R}$	49	$\pm I_{10L}$
16	$\pm Q_{3L}$	16	$\pm Q_{5R}$	16	$\pm Q_{5R}$	50	$\pm Q_{10L}$
17	$\pm I_{2L}$	17	$\pm I_{6R}$	17	$\pm I_{6R}$	51	$\pm I_{9L}$
18	$\pm Q_{2L}$	18	$\pm Q_{6R}$	18	$\pm Q_{6R}$	52	$\pm Q_{9L}$
19	$\pm I_{1L}$	19	$\pm I_{7R}$	19	$\pm I_{7R}$	53	$\pm I_{8L}$
20	$\pm Q_{1L}$	20	$\pm Q_{7R}$	20	$\pm Q_{7R}$	54	$\pm Q_{8L}$
		21	$\pm I_{8R}$, $\pm I_{8L}$	21	$\pm I_{8R}$	55	$\pm I_{7L}$
		22	$\pm Q_{8R}$, $\pm Q_{8L}$	22	$\pm Q_{8R}$	56	$\pm Q_{7L}$
		23	$\pm I_{7L}$	23	$\pm I_{9R}$	57	$\pm I_{6L}$
		24	$\pm Q_{7L}$	24	$\pm Q_{9R}$	58	$\pm Q_{6L}$
		25	$\pm I_{6L}$	25	$\pm I_{10R}$	59	$\pm I_{5L}$
		26	$\pm Q_{6L}$	26	$\pm Q_{10R}$	60	$\pm Q_{5L}$
		27	$\pm I_{5L}$	27	$\pm I_{11R}$	61	$\pm I_{4L}$
		28	$\pm Q_{5L}$	28	$\pm Q_{11R}$	62	$\pm Q_{4L}$
		29	$\pm I_{4L}$	29	$\pm I_{12R}$	63	$\pm I_{3L}$
		30	$\pm Q_{4L}$	30	$\pm Q_{12R}$	64	$\pm Q_{3L}$
		31	$\pm I_{3L}$	31	$\pm I_{13R}$	65	$\pm I_{2L}$
		32	$\pm Q_{3L}$	32	$\pm Q_{13R}$	66	$\pm Q_{2L}$
		33	$\pm I_{2L}$	33	$\pm I_{14R}$	67	$\pm I_{1L}$
		34	$\pm Q_{2L}$	34	$\pm Q_{14R}$	68	$\pm Q_{1L}$
		35	$\pm I_{1L}$	35	$\pm I_{15R}$		
		36	$\pm Q_{1L}$	36	$\pm Q_{15R}$		
				37	$\pm I_{16R}$, $\pm I_{16L}$		
				38	$\pm Q_{16R}$, $\pm Q_{16L}$		

Table 3. Bit-reversed shuffling



Input operations	Program phrases	Step numbers	Functions
Key-In: ±M Press A	Lb1 A	000	Store ±M in R_{70}, $N=2^{\lvert M\rvert}$
	STO 70 PRT	002	
	OP 10 STO 69	005	Store signum M in R_{69}
	2y^{x}RCL 70 |x|)EE INV EE STO 00	009	Calculate N, discard guard digits, store in R_{00}
	5 STO 79 R/S	020	Initialize storage index for data
	MANUAL DATA INPUT SECTION		
If data input is manual key-in Real Pt. 1 R/X Imag Pt. 1 R/S Real Pt. 2 R/S Press B	ST*79 PRT	024	
	1 SUM 79 R/S	027	Store data
	GTO 024	031	R_{05} to R_{68} reserved for data
	IN-PLACE BIT-REVERSED SHUFFLING SECTION		
	LB1 B	034	
	RCL 00÷)STO 78	036	Initialization of
	RCL 00−2)STO 77	043	loop parameters
	1 STO 75 STO 74	050	Initialization of data addresses
	RCL 75 ×⇄t	055	Compare index and its
$R_{74} \geqslant R_{75}$	RCL 74 GE 096	058	bit-reversed equivalent (BRE) interchange only if index is less than BRE
	$R_{74} < R_{75}$		
	×2+3)STO 71 RCL 75 ×2+3)STO 72	063	Form actual TI-59 addresses
	RC*72 EX*71 ST*72	079	Interchange BRE data cells, real
	1 SUM 71 SUM 72	085	Increment addresses
	RC*72 EX*71 ST*72	090	Interchange BRE imaginaries
	RCL 78 STO 73	096	Initialize powers of two
	RCL 75 ×⇄t	100	
$R_{73} \geqslant R_{75}$	RCL 73 GE 119	103	Compare BRE with index
	$R_{73} < R_{75}$		
	+/−)SUM 75	108	
	2 INV PRD 73	112	Form BRE
	GTO 100	116	
	SUM 75 1 SUM 74	119	Increment index
	Dsz 77 055	124	Loop over all points
	TO TRANSFORM SECTION		

Highly reliable, open and enclosed frame, single and multiple output. Precisely regulated for general purpose as well as MICROPROCESSOR based systems. Available from 6 Watts to 250 Watts standard.

ELPAC POWER SYSTEMS
3131 Standard Avenue, Santa Ana, CA 92705
(714) 979-4440 TWX 910-595-1513

The "quiet" switcher. Low noise, high density, pulse-width modulated, 20KHz. Single and multiple output, open and enclosed frame. State-of-the-art technology providing high regulation, and extended reliability. Available in a wide range of power levels.

ELPAC POWER SYSTEMS
3131 Standard Avenue, Santa Ana, CA 92705
(714) 979-4440 TWX 910-595-1513

CIRCLE NO. 85

Table 4. Fourier Transformation

From Bit-Reversed Shuffling	Program Steps	Functions
2 STO 78	128	Initialization of Power of Two
RCL 78÷2)STO 75	131	No. of Points in Butterfly
1 STO 72	138	Initialization of Relative Point Index
RCL 72−1)×π×2×RCL 69 ÷RCL 78)STO 73	141	Form the Kernel
COS STO 74	159	Cos (kernel) Stored
RCL 73 SIN STO 73	162	Sin (kernel) Stored
RCL 72×2+RCL 78+3)STO 71	167	Initialization TI-59 Location Index
RCL 74 PGM04 A	179	
RCL 73 PGM04 A	184	Complex multiply of kernel and a point to form intermediate factor
RC*71 PGM04 A^1	189	
1 SUM 71	194	
RC*71 PGM04 A^1	197	
PGM04 C	202	
STO 77 x⇄t STO 76	205	Store real and imaginary parts
RCL 78 INV SUM 71	210	
RCL 76 SM*71 RC*71−2×RCL79)	215	
x⇄t	227	
RCL 78 SUM 71 RCL 71	228	
x⇄t ST*71 †① ② ③	234	Form elements of the butterfly
RCL 78+1)INV SUM 71	237	
RCL 77 SM*71RC*71	245	
x⇄t	251	
RCL 78 SUM 71 RCL 71	252	
x⇄t 2XRCL 77)ST*71	258	
RCL00X2+5)x⇄t	267	
2×RCL78)SUM 71 RCL 71	275	Incrementing of butterfly parameters
INV GE 179	284	
$R_{71}<R_t$ $R_{71}\geq R_t$		
1 SUM 72	288	
Dsz 75 141	291	Butterfly order loop
2 PRD 78 PRT	295	Increment power of two
Dsz 70 131	299	Print "2" for Each Loop Traverse
5 STO 79 ADV	303	END.
RC*79 PRT	307	Output stored in R_{05}, R_{06}, . . . R_{68} and printed
1 SUM 79	310	
Dsz 78 307	313	
ADV ADV	317	
R/S	319	

†Three major loops

next 13 minutes of computation (for 32 points), a progress-report, numeral 2 is printed at step 298 to signal each time the outer loop is completed. For eight data points, then, three 2s are printed; for 16 points, four 2s; and for 32 points, five 2s. The transform output spectrum, which is in the computer's registers in the order listed in Table 2, is printed automatically.□

References

1. Rabiner, L. R., and Gold, B., "Theory and Application of Digital Signal Processing," Prentice-Hall, Englewood Cliffs, NJ, 1975, p. 367.

2. Schirm, Louis, IV, "Get to know the FET and Take Advantage of Speedy LSI Building Blocks," ELECTRONIC DESIGN, April 26, 1979, p. 78.

How useful?	Circle No.
Immediate design application	568
Within the next year	569
Not applicable	570

Now there's a 20 MHz gate array that outperforms TTL and low power Schottky!

Introducing high-speed CML Monochips.™

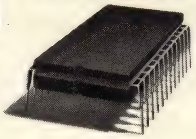
In today's competitive design race, Interdesign gives you the edge you need to win. CML Monochips are fast enough, large enough, and flexible enough to satisfy a variety of functions in computer, telecommunications, and instrumentation designs.

With toggle rates to 20 MHz and propagation delays as low as 3 nsec, CML Monochips give you the speed you need with a minimum power requirement.

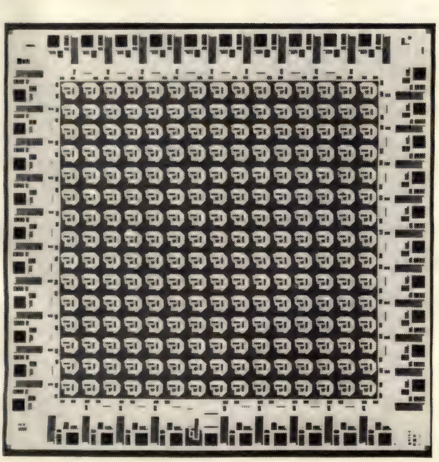
Monochip CML IC's are easy to design because we've simplified the chip's architecture. Our $25 Design Manual gives you everything you need to lay out your own custom 450- or 880-gate array. Working from your layout, we'll deliver 20 prototypes in 8 to 10 weeks for your evaluation. Once you've approved them, we'll make 1,000 to 500,000 parts for you.

CML Monochips give you all the advantages of custom IC's without the cost or lead time of full custom development. For more information, call or write us today. Interdesign Inc., 1255 Reamwood Avenue, Sunnyvale, CA 94086. Telephone: (408) 734-8666. TWX: 910 339 9374.

Interdesign



Monochip:™
the semi-custom IC.

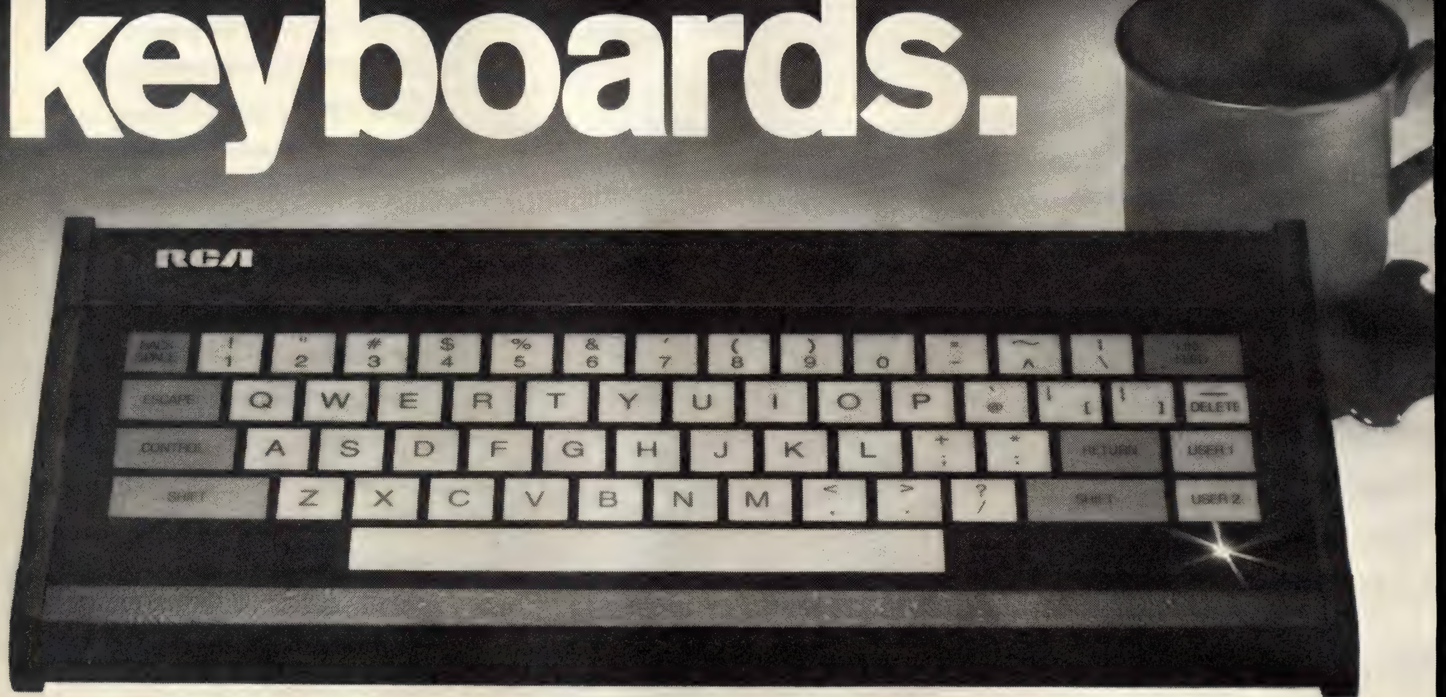


Typical Applications
- Disk and CRT Controllers
- Dynamic and Static Memory Controllers
- Keyboard Scanners
- Memory Interface Logic
- Control Logic — CPU Boards
- ALU Accumulators
- D/A — A/D Controllers

Interdesign is a Ferranti Company

CIRCLE NO. 87

spillproof ASCII encoded keyboards.



Serial output from $57.*
Parallel output from $49.*

RCA VP-600 series ASCII keyboards are available in two formats: 58-key typewriter format for alpha-numeric entry. Or a 74-key version, featuring typewriter format plus a 16-key calculator-type keypad. Both can be ordered with parallel or serial output.

Spillproof keyboards.

These keyboards feature modern flexible membrane key switches with contact life rated at greater than 5 million operations. Plus two key rollover circuitry. A finger positioning overlay combined with light positive activation key pressure gives good operator "feel," and an on-board tone generator gives aural key press feedback.

The unitized keyboard surface is spillproof and dustproof. This plus high noise immunity CMOS circuitry makes these keyboards particularly suited for use in hostile environments.

All operate from low power 5V DC, excluding implementation of RS232C.

For more information, contact RCA Customer Service, New Holland Avenue, Lancaster, PA 17604.

Or call our toll-free number: 800-233-0094.

Parallel output keyboard features:

- 7-bit parallel ASCII encoded output. Buffered CMOS and TTL compatible. Drives 2 TTL loads.
- Even parity bit, unbuffered.
- Keydown, $\overline{\text{keydown}}$, strobe, $\overline{\text{strobe}}$ handshake signals.
- Power-on LED indicator.
- 20-pin PC board header connector.

Serial output keyboard features:

- 3 ASCII encoded outputs: EIA RS232C compatible. 20 mA current loop. TTL.
- Switch-selectable data format.
- Six baud rates, switch-selectable.
- Power-on or "prompt" LED indicator.
- 25-pin output socket mates with male "D" cable connector.

RCA

*OEM price.

CIRCLE NO. 88

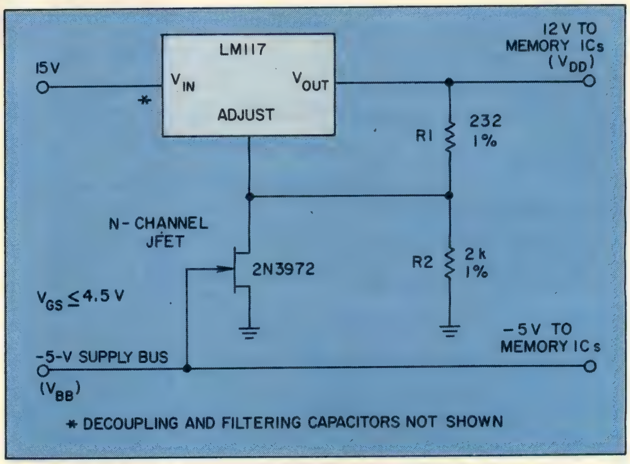
Simple power-sequencing control prevents dynamic-memory damage

Combine the shutdown feature of an LM117 IC regulator with the clamping and voltage-sensing capabilities of a normally-on 2N3972 JFET, and the result is a reliable, low-cost power-sequencing circuit for multisupply dynamic memories. Proper power sequencing prevents damage to dynamic memory during turn-on, turn-off, when transients are present or if the −5-V supply fails.

Dynamic-memory ICs with multiple supplies, such as the 16-kbit 4116, require that V_{BB} (−5 V) not be absent when V_{DD} (12 V) is applied, or that V_{BB} never be more positive than V_{SS} (ground) when V_{DD} is applied. For the 4116, V_{BB} must never be more than 0.2 V positive with respect to V_{SS} when V_{DD} is applied. Thus, a diode clamp from V_{BB} to V_{SS} does not provide adequate protection for the easily damaged dynamic memory.

The sequencing circuit (see Fig.) provides the protection needed by sensing the absence of the −5-V supply to turn off the 12-V supply (or prevent it from turning on). Sequencing is achieved at shutdown by clamping the R_1/R_2 junction and the adjustment terminal of the LM117 to ground with a 2N3972 JFET. Clamping causes the LM117 output (set by R_1 and R_2 at 12 V) to drop to 1.2 V. This low voltage is enough to power-down the 4116s and prevent damage even if the negative supply floats slightly positive.

The 2N3972 JFET (with a specified −0.5 to −3-V cutoff) senses when V_{BB} is at least 0.5 V negative and turns off, allowing the LM117 to turn on V_{DD} (12 V). If V_{BB} goes off for any reason, the JFET turns on, clamping the LM117's cutoff terminal to ground and turning off V_{DD}. The JFET has a cutoff voltage (V_{GS}) less than −4.5 V (below the −5-V supply's minimum tolerance) so that the LM117 can deliver its full output under all normal operating conditions.



A simple power-sequencing control for dynamic-memory ICs, such as the 16-kbit 4116 RAM, prevents component damage during turn-on, turn-off, when transients are present or if the −5-V supply fails.

The sequencing circuit can power a small memory system from a central supply since one LM117 in to TO-3 package can deliver 1.5 A at 12 V—sufficient current to operate a good number of 4116s.

J.E. Buchanan and C.W. Nelson, Electrical Engineers, Westinghouse Electric Corp., P.O. Box 746, MS 1645, Baltimore, MD 21203.

CIRCLE NO. 311

Stable ac-level detector monitors microwave radio-link pilot tones

A few components comprise a stable, sensitive, ac-level detector: a diode array, a single op-amp, four capacitors and a handful of precision resistors. The circuit is particularly suited to detecting pilot tone levels for microwave radios. A 3-dB (or greater) drop in pilot tone level (measured at the microwave receiver) indicates a bad microwave link. The detector circuit is useful from audio to rf frequencies around 100 MHz.

The pilot tone is a stable, level, single-frequency signal inserted into the radio baseband at a microwave transmitter. The level detector circuit (see Fig.) is preceded by a bandpass filter (not shown) which selects only the pilot frequency at the microwave receiver.

Incoming ac (pilot signal) is applied to the biased diode detectors D_1 and D_2. The detected output level is filtered, producing voltage V_A, and V_A is amplified to increase overall sensitivity.

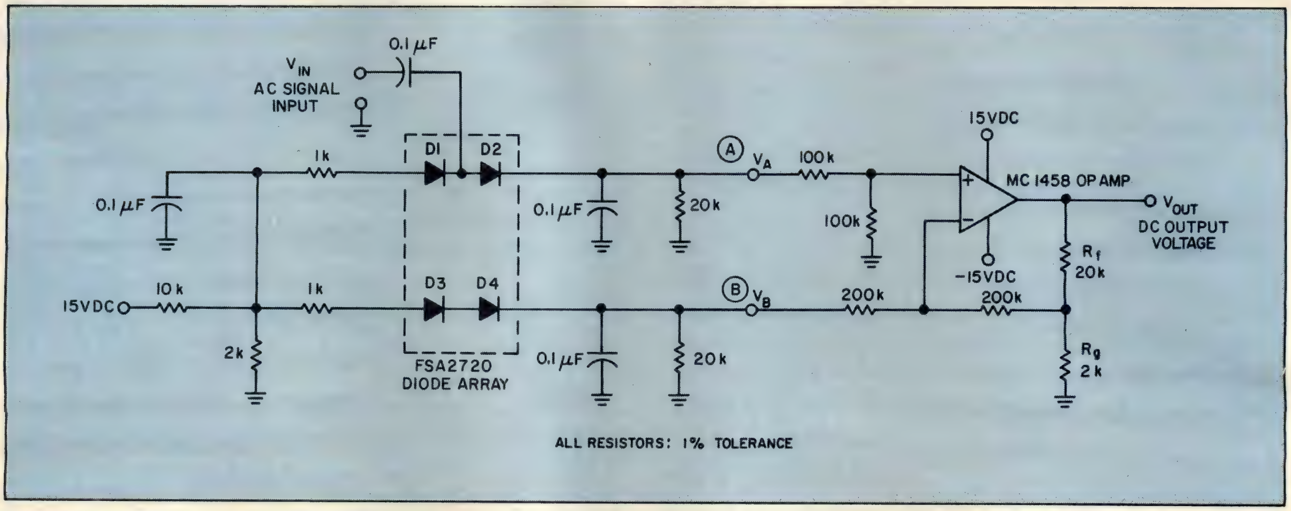
The detector circuit has inherent temperature stability, as a result of two factors. First, all diodes are in a monolithic array. Any temperature-related voltage change across D_1 and D_2 (that changes V_A) is tracked by a corresponding voltage change across D_3 and D_4 (that changes V_B). The amplifier gain is $(V_A-V_B) \times (R_f+R_g)/R_g$; therefore, V_{OUT} can change only when level shifts affecting V_{IN} occur.

Temperature stability also results from the loading of the amplifier circuit. The input impedances looking into points A and B are each 200 kΩ and are very nearly equal (within 1%). High impedance with equal loading keeps the amplifier from affecting dc bias levels within the two diode arms.

With V_{IN} at 200-mV (p-p), derived from a 1-MHz 600-Ω generator, the detection sensitivity is 10 V/V (p-p). The dc output level is accurate to within 1 dB of the input level from −10 to 50 C. Amplifier gain is 11, and can be increased or decreased by varying R_f.

Robert G. Golasa, Engineer, Digital Products, Farinon Electric, 1691 Bayport Ave., San Carlos, CA 94070.

CIRCLE NO. 312



Useful to 100 MHz, this temperature-stable ac-level detector monitors microwave radio pilot tones at 308 kHz. DC gain is provided (rather than rf gain) to increase circuit sensitivity; dc gain stability is easier to control.

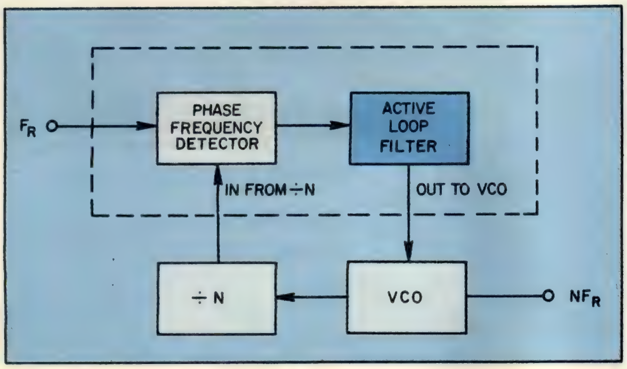
Norton amps simplify active filter design

Active filters that use Norton amplifiers instead of operational amplifiers simplify the circuitry required to provide frequency multiplication with a phase-locked loop (Fig. 1). What's more, a computer program eliminates the tedious calculation otherwise required to select practical passive component values for the filter.

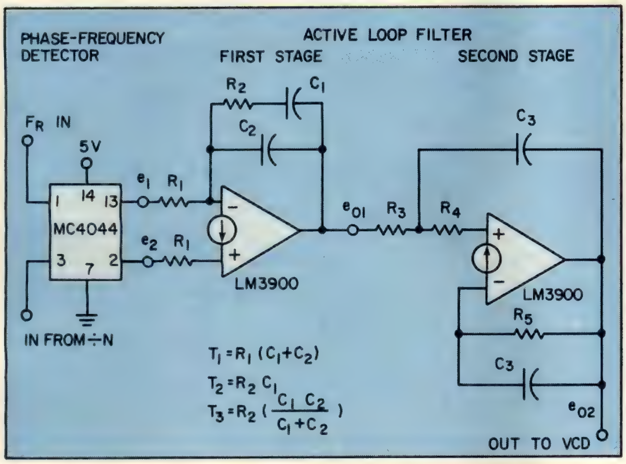
And while reducing PLL active loop filter complexity, Norton amps also allow the frequency multiplier's phase frequency detector (Motorola's MC4044) to deliver reduced phase noise. Although the MC4044 can provide a single-ended output from an internal charge pump, excessive phase noise appears on the voltage-controlled oscillator (VCO) output when the charge pump is used. This noise is greatly reduced when the differential output from the TTL circuits is used directly, an option made possible with the Norton-amplifier circuit (Fig. 2).

Time constant T_1 and T_2 in the active loop filter's first stage determine the loop bandwidth and damping. The remainder of the circuit is a three-pole active filter used to attenuate the phase-detector input frequency and prevent it from modulating the VCO. Time constant T_3 establishes the real axis filter pole; the complex poles are realized by the active loop filter's second stage.

All component values for both stages of the active loop filter can be calculated by a Basic computer program (Fig. 3). The program first requires input values for damping factor (ζ), undamped natural frequency (ω_n in radians/s), filter cutoff frequency (F_c in Hz), and phase-detector reference frequency



1. The active loop filter in a phase-locked loop can be simplified when designed with Norton amplifiers instead of *operational* amplifiers.

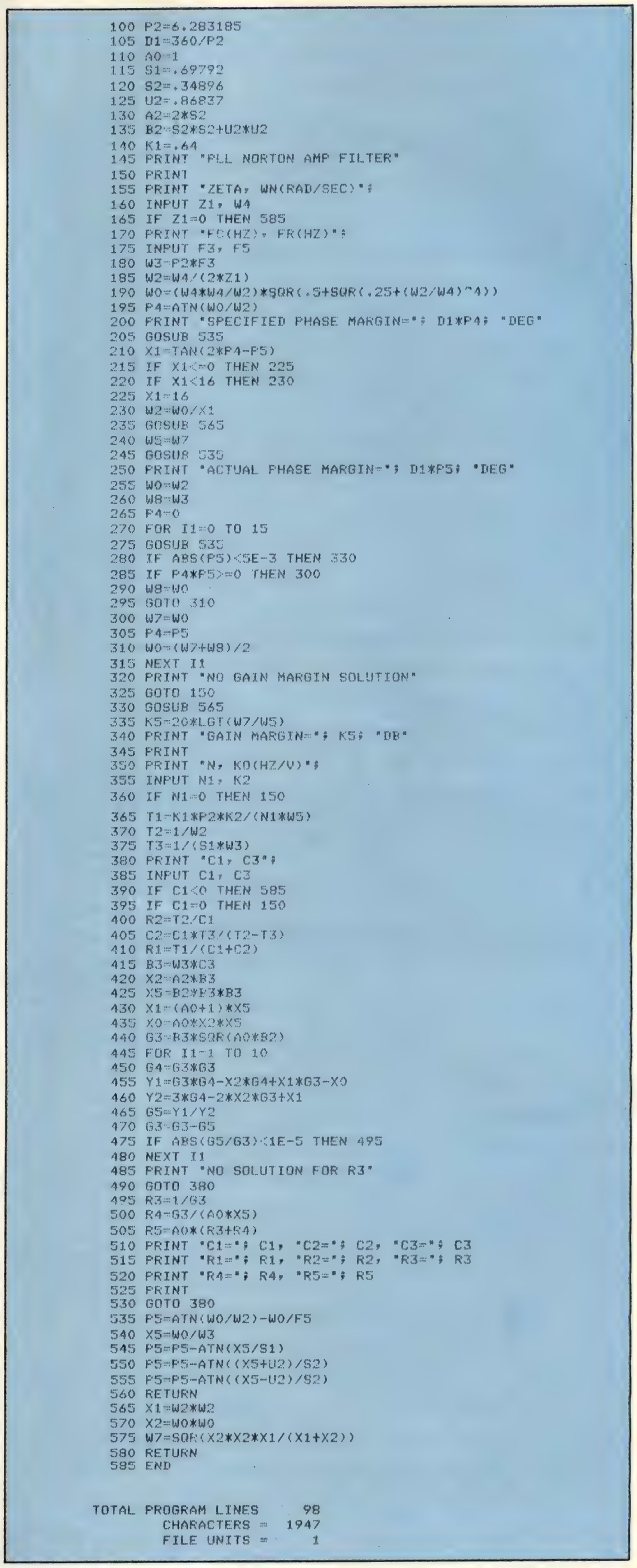


2. A Norton amplifier, when implemented in an active loop filter, may have a differential input (first stage) or may be used in a noninverting mode (second stage).

(F_R in Hz). (The reference frequency is required to calculate the phase shift caused by time delay through the frequency divider). For sufficient reference frequency attenuation, F_c should be less than a fifth of the phase detector input frequency. For loop stability, ω_n must be less than F_c.

The program determines loop stability for the combination of values chosen by calculating phase margin and gain margin (these calculations are based on low-pass filter prototype poles). These values, set in lines 115 through 125 of the program, are for a Chebyshev filter having a 3-dB bandwidth of 1 radian/s and 0.1-dB ripple.

Note that ζ and ω_n are factors in the closed-loop transfer function of a loop with only two poles, and thus do not strictly apply to a loop with divider delay and a three-pole low-pass filter. The program first calculates the open-loop bandwidth and phase margin of the specified two-pole loop. Then it adjusts ω_n and corner frequency ω_2 to provide equivalent open-loop bandwidth and—if possible—phase



```
100 P2=6.283185
105 D1=360/P2
110 A0=1
115 S1=.69792
120 S2=.34896
125 U2=.86837
130 A2=2*S2
135 B2=S2*S2+U2*U2
140 K1=.64
145 PRINT "PLL NORTON AMP FILTER"
150 PRINT
155 PRINT "ZETA, WN(RAD/SEC)";
160 INPUT Z1, W4
165 IF Z1=0 THEN 585
170 PRINT "FC(HZ), FR(HZ)";
175 INPUT F3, F5
180 W3=P2*F3
185 W2=W4/(2*Z1)
190 W0=(W4*W4/W2)*SQR(.5+SQR(.25+(W2/W4)^4))
195 P4=ATN(W0/W2)
200 PRINT "SPECIFIED PHASE MARGIN="; D1*P4; "DEG"
205 GOSUB 535
210 X1=TAN(2*P4-P5)
215 IF X1<=0 THEN 225
220 IF X1<16 THEN 230
225 X1=16
230 W2=W0/X1
235 GOSUB 565
240 W5=W7
245 GOSUB 535
250 PRINT "ACTUAL PHASE MARGIN="; D1*P5; "DEG"
255 W0=W2
260 W8=W3
265 P4=0
270 FOR I1=0 TO 15
275 GOSUB 535
280 IF ABS(P5)<5E-3 THEN 330
285 IF P4*P5>=0 THEN 300
290 W8=W0
295 GOTO 310
300 W7=W0
305 P4=P5
310 W0=(W7+W8)/2
315 NEXT I1
320 PRINT "NO GAIN MARGIN SOLUTION"
325 GOTO 150
330 GOSUB 565
335 K5=20*LGT(W7/W5)
340 PRINT "GAIN MARGIN="; K5; "DB"
345 PRINT
350 PRINT "N, KO(HZ/V)";
355 INPUT N1, K2
360 IF N1=0 THEN 150
365 T1=K1*P2*K2/(N1*W5)
370 T2=1/W2
375 T3=1/(S1*W3)
380 PRINT "C1, C3";
385 INPUT C1, C3
390 IF C1<0 THEN 585
395 IF C1=0 THEN 150
400 R2=T2/C1
405 C2=C1*T3/(T2-T3)
410 R1=T1/(C1+C2)
415 B3=W3*C3
420 X2=A2*B3
425 X5=B2*B3*B3
430 X1=(A0+1)*X5
435 X0=A0*X2*X5
440 G3=B3*SQR(A0*B2)
445 FOR I1=1 TO 10
450 G4=G3*G3
455 Y1=G3*G4-X2*G4+X1*G3-X0
460 Y2=3*G4-2*X2*G3+X1
465 G5=Y1/Y2
470 G3=G3-G5
475 IF ABS(G5/G3)<1E-5 THEN 495
480 NEXT I1
485 PRINT "NO SOLUTION FOR R3"
490 GOTO 380
495 R3=1/G3
500 R4=G3/(A0*X5)
505 R5=A0*(R3+R4)
510 PRINT "C1="; C1, "C2="; C2, "C3="; C3
515 PRINT "R1="; R1, "R2="; R2, "R3="; R3
520 PRINT "R4="; R4, "R5="; R5
525 PRINT
530 GOTO 380
535 P5=ATN(W0/W2)-W0/F5
540 X5=W0/W3
545 P5=P5-ATN(X5/S1)
550 P5=P5-ATN((X5+U2)/S2)
555 P5=P5-ATN((X5-U2)/S2)
560 RETURN
565 X1=W2*W2
570 X2=W0*W0
575 W7=SQR(X2*X2*X1/(X1+X2))
580 RETURN
585 END


TOTAL PROGRAM LINES      98
         CHARACTERS =  1947
         FILE UNITS =     1
```

3. All the component values for the active loop filter of Fig. 2 may be calculated with this Basic computer program. The user must select input values for damping factor ζ, undamped natural frequency ω_n, filter cutoff frequency F_c and phase detector reference frequency F_R.

margin in the actual loop. This produces approximately the same closed-loop characteristics as those of the specified two-pole loop.

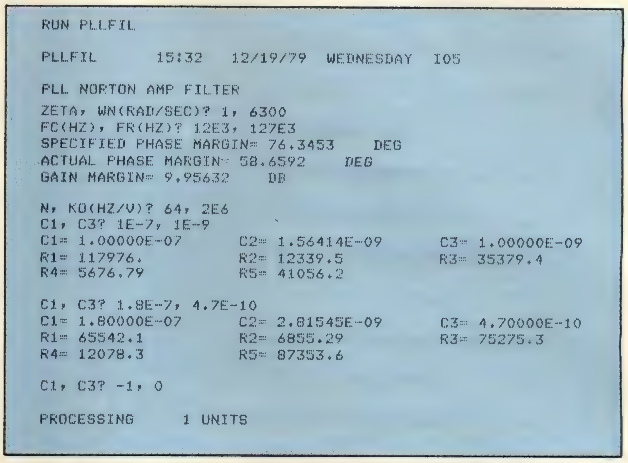
Division ratio (N) and VCO sensitivity (in Hz/V) are the next input data values required. The MC4044 detector sensitivity is 0.64 V/radian when used in this circuit. That value is assigned in program line 140. Values for capacitors C_1 and C_3 are then selected, and the program calculates C_2 and the resistor values. Should the resistor values prove impractical, new values for C_1 and C_3 can be selected.

Resistor-value calculation for the second stage of the filter involves a cubic equation, which is solved in program lines 415 through 505 by Newton-Raphson iteration. Fig. 4 shows a sample program run.

The Norton amplifiers used in the active filter are typically National Semiconductor LM3900s, which operate from a single supply voltage and may be used in an inverting or a noninverting configuration, or may have a differential input. (A new wide-bandwidth LM359, which recently has become available, could also be used). In addition, any supply voltage between 5 and 36 V can be used, as determined (usually) by the required VCO control-voltage range.

Jack Porter, Senior Technical Specialist, Cubic Corp., Defense Systems Div., 9333 Balboa Ave., San Diego, CA 92123.

CIRCLE NO. 313



```
RUN PLLFIL

PLLFIL       15:32   12/19/79  WEDNESDAY  IO5

PLL NORTON AMP FILTER
ZETA, WN(RAD/SEC)? 1, 6300
FC(HZ), FR(HZ)? 12E3, 127E3
SPECIFIED PHASE MARGIN= 76.3453    DEG
ACTUAL PHASE MARGIN= 58.6592    DEG
GAIN MARGIN= 9.95632    DB

N, KO(HZ/V)? 64, 2E6
C1, C3? 1E-7, 1E-9
C1= 1.00000E-07        C2= 1.56414E-09        C3= 1.00000E-09
R1= 117976.            R2= 12339.5            R3= 35379.4
R4= 5676.79            R5= 41056.2

C1, C3? 1.8E-7, 4.7E-10
C1= 1.80000E-07        C2= 2.81545E-09        C3= 4.70000E-10
R1= 65542.1            R2= 6855.29            R3= 75275.3
R4= 12078.3            R5= 87353.6

C1, C3? -1, 0

PROCESSING     1 UNITS
```

4. This sample program run completely specifies the component values for the active loop filter.

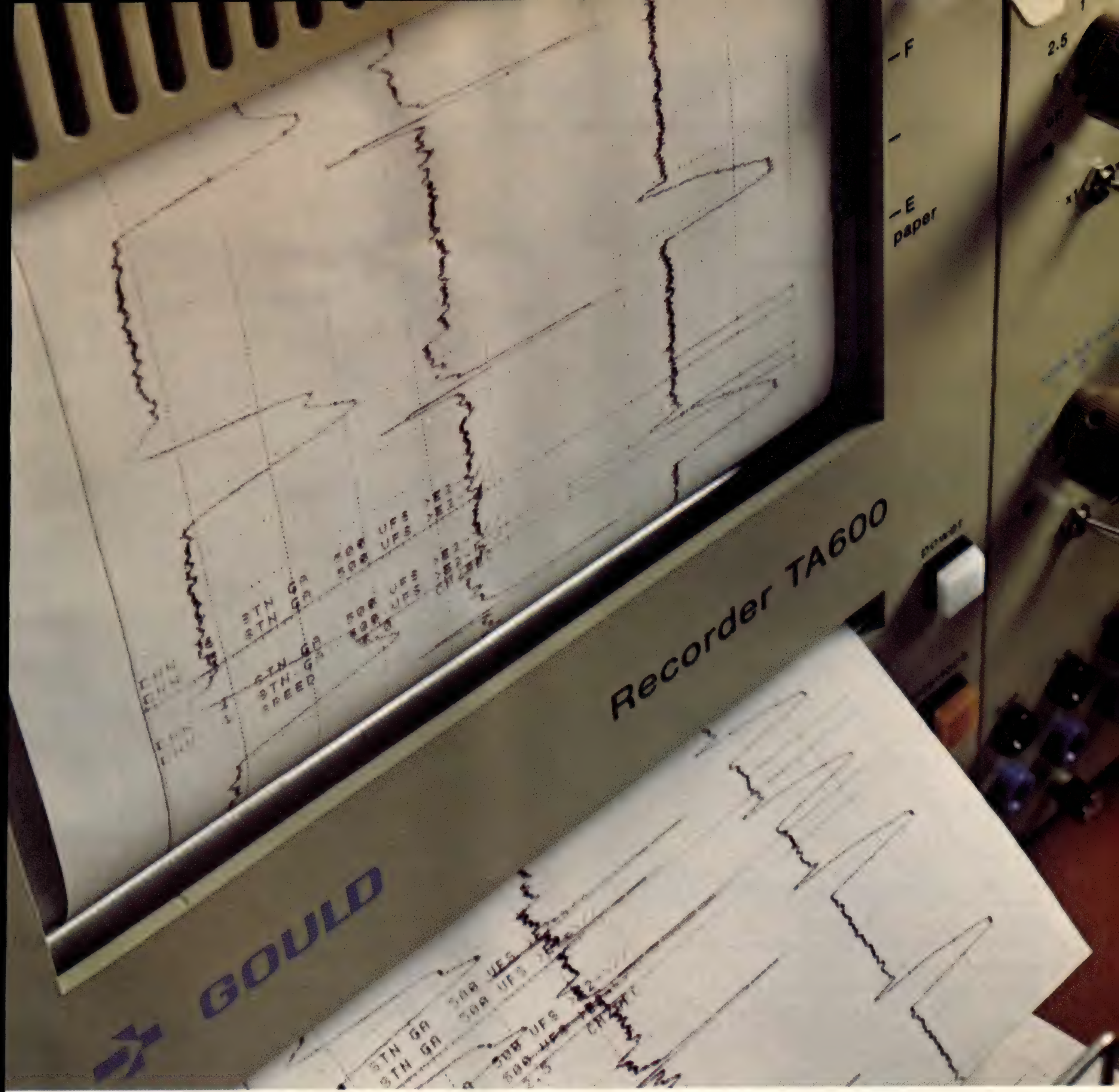
Transistor generates vhf shot noise

The collector-noise current of a junction transistor can generate known levels of wideband noise for checking vhf receiver performance and for providing a wideband noise reference. What's more, the transistor noise-generator circuit in Fig. 1 can be an effective alternative to vacuum noise diodes and other performance-limited semiconductor noise sources. Vacuum noise diodes, while generating "shot noise" (random electron motion) over a wide frequency spectrum, are expensive, typically consume several watts, and have a relatively slow response time. Semiconductor diodes (including zener types), while providing simple, low-cost and lower power sources of uncalibrated noise, exhibit significant thermal-noise components and generally have nonlinear performance that limits them to noncritical applications.

For the best noise-generator performance, select transistors with low collector capacitance and an alpha cutoff frequency (f_α) much less than the frequency of interest (this is the case for the 2N4359, and the 2N3962). A pnp transistor is generally preferred as a noise generator because of its lower f_α for a given device geometry.

Junction-transistor collector current has components of both thermal and shot noise, but the thermal-noise portion is frequency-dependent. Significant thermal and shot-noise components exist at low and midband frequencies, while shot noise predominates at high frequencies. Collector mean-square noise current ($\overline{i^2}$) at high frequencies is $\overline{i^2} = kqIB$, where k is a frequency-dependent constant that closely approaches 2 at $f >> f_\alpha$, q is electronic charge (1.6×10^{-19} coulombs), I is collector current and B is bandwidth. The shot-noise voltage level generated by a 2N4359 transistor is determined by both the collector current and the collector load resistance, R_L.

The 2N4359 has a noise linearity of better than 2%, is relatively independent of ambient tem-



The new Gould TA 600 aids trace interpretation by automatically annotating your chart record. You see chart speed, amplifier sensitivity setting, real time, and test identification. Individual events, time frames, and responses can be quickly and precisely determined. An optional microprocessor controls chart speed, user IO functions, overall printing, and specifically the printing of user messages, chart speeds, range settings, grid lines, and user raster data.

The TA 600 packs a lot of information into its traces, too. Analog signals are sampled 1600 times a second by a discrete analog to digital converter. The high peak capture capability registers any transient lasting longer than 625 microseconds at its full value. You get a square wave frequency response of 20 Hz full scale and a high frequency capture capability better than 500 Hz full scale.

The TA 600 has a reliable, fixed thermal array writing system that eliminates ink, pens, overshoot, hysteresis and worn out parts. Because the grid lines are generated along with the traces, you're assured of an accurate record unaffected by chart wander or chart speed variation. Overlapping traces on the 130mm (5.12") wide chart allow full scale recording for each of up to 32 channels.

Find out more about what the new, rugged, dependable TA 600 can tell you about *your* data. Contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, Ohio 44114.

For brochure call toll-free: (800) 331-1000. In Oklahoma, call collect 918-664-8300.

In Europe, contact
Gould Instruments S.A.F.,
57 rue St. Sauveur,
91160 Ballainvilliers,
France.

GOULD
An Electrical/Electronics Company

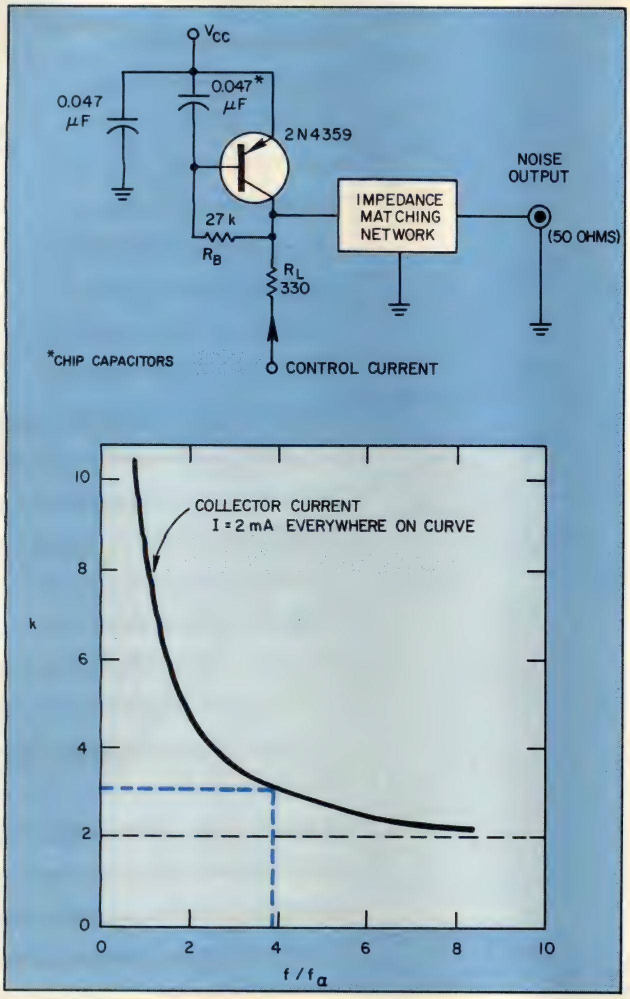
The new Gould TA600 thermal array recorder. It tells you what your traces mean.

CIRCLE NO. 89

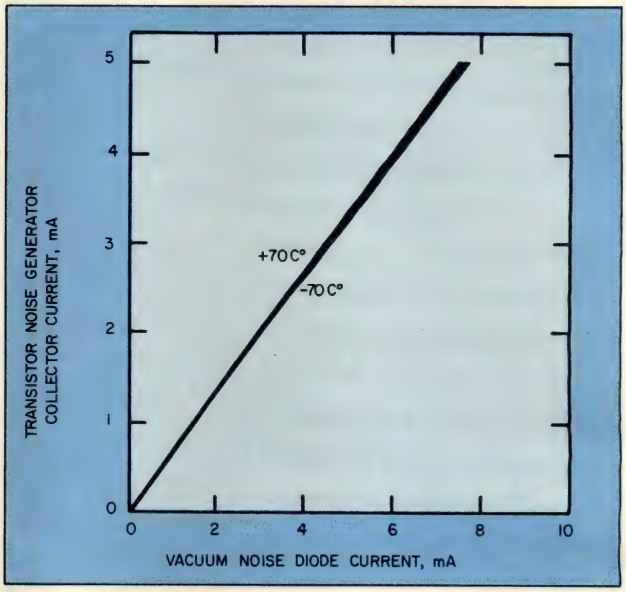
perature effects (Fig. 2), and has fast response. Its noise performance at vhf approaches that of vacuum devices. How useful the noise generator can be at upper vhf frequencies is ultimately limited by transistor collector time constant C_0R_L. At 30 MHz and above, performance between devices has been observed to be both stable and repeatable.

Ian G. Bird, Divisional Engineer, CSIRO Division of Atmospheric Physics, P.O. Box 77, Mordialloc, Victoria 3195, Australia.

CIRCLE NO. 314



1. Bypass-capacitor chips ensure that the transistor noise generator's base and emitter are effectively grounded at vhf. Dc operating conditions require that base resistor, R_B, be less than or equal to $100R_L$ (e.g., for $R_L = 330\ \Omega$, $R_B = 27\ k\Omega$). The curve details how the noise generator's output is frequency-dependent (operating point used in Fig. 2 shown in color).



2. Compare the transistor noise generator of Fig. 1 (operating at $f \simeq 4f\alpha$, $k = 3$) and a vacuum-noise reference diode, where f is 30 MHz: A 0.04%/°C temperature coefficient crops up in the generated noise (changing line width) while a nonlinearity at collector currents below 0.5 mA is barely discernible.

Solar power-supply regulator consumes less than 1 mA

A monolithic low-power voltage detector is the heart of a very efficient shunt voltage regulator for solar-powered electric-generating equipment. The shunt voltage regulator (Fig. 1) consumes less than 1 mA; eliminates the voltage drop a series regulator design would introduce; and avoids electrolyte losses from battery overcharges.

The use of a Schottky-barrier diode as the blocking diode increases the efficiency of the regulator in systems that provide up to 24 V. The diode has a forward voltage drop of about 0.4 V. For systems providing more than 24 V, p-n junction silicon diodes are preferable, because of their higher blocking capacity.

The Intersil ICL 8211M voltage detector compares the system's voltage (through resistor divider R_1 and R_2) with an internal reference of 1.15 V (Fig. 2). When the voltage at the threshold input is lower than the

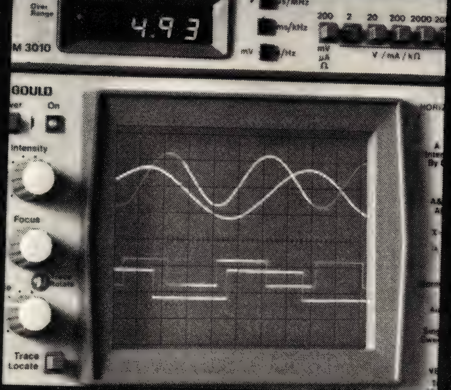
Now—Gould quality in a 100 MHz oscilloscope.

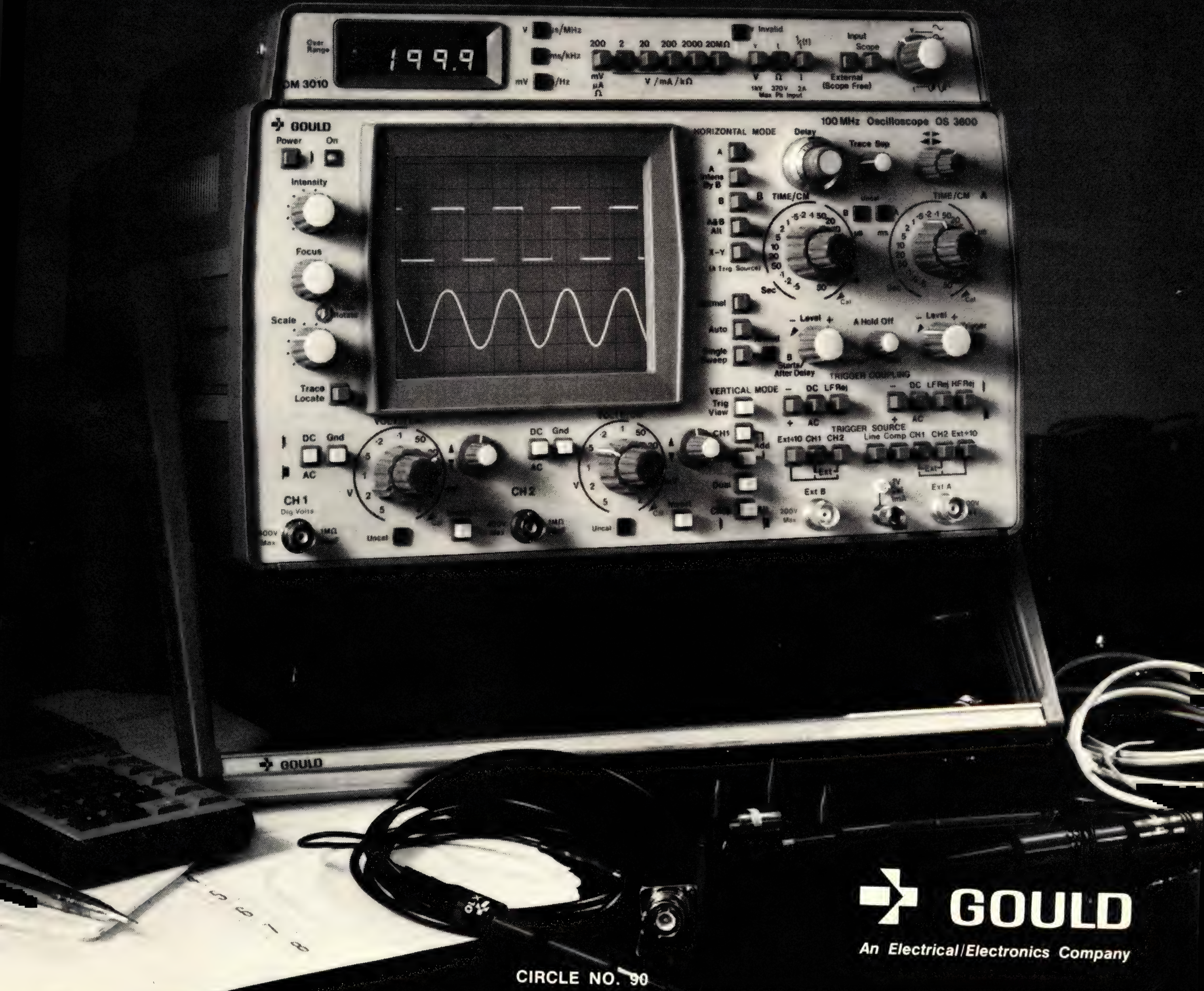
No scope on the market has more of the features you need than the new Gould OS3600 with optional DMM. You can use the OS3600 on any electrical/electronic circuit from digital to conventional with exceptional results.

With vertical sensitivity of 2mV/cm up to 85 MHz, the OS3600 can examine extremely low level signals. The 4-trace capability allows comparison of original and delayed sweeps.

The bright, flicker-free CRT displays even narrow pulses with low repetition rates. The optional 3½ digit DMM is available as a factory fit or retrofit. Plus, the OS3600 is backed by a worldwide service network and a unique 2-year warranty that covers all parts and labor (exclusive of fuses, calibration, or minor maintenance).

Write Gould Inc., Instruments Division, 3631 Perkins Avenue, Cleveland, OH 44114. Call toll free 800-331-1000 (in Oklahoma, call collect 918-664-8300).





GOULD

An Electrical/Electronics Company

CIRCLE NO. 90

reference, the output terminal sinks current, presenting a low saturation voltage. When the voltage at the threshold input is higher than the reference, the output terminal remains high and only a few microamps of leakage current flows.

The detector's output controls the gates of three parallel VMOS power FETs. The excess current is dissipated in power resistor R_4. C_1 and C_2 provide loop stability.

The regulated voltage available is:

$$V = 1.15\left(\frac{R_1 + R_2}{R_2}\right).$$

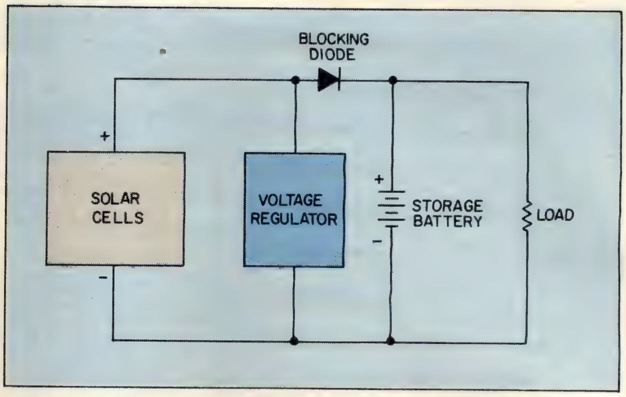
To avoid overcharging lead-acid batteries, R_1 and R_2 should be chosen so the regulated voltage does not exceed the drop in the blocking diode, plus 2.3 to 2.4 V for each series battery cell. Both R_1 and R_2 should have low temperature coefficients. The dissipation resistor and power FETs should have a current rating at least equal to that of the solar cells. VMOS FETs are recommended for their low cost, minimal current drive requirements, high reliability and wide operating range with temperature.

The ICL 8211, which is used in the 5-A, 12-V system of Fig. 2, has a 30 V rating. For higher voltage systems, the supply connection (pin 8) should be tied to the voltage dropper R_D and D_1. Higher currents require a larger power resistor and heavy duty transistor(s). (Three parallel transistors are shown; but single high-current devices are readily available).

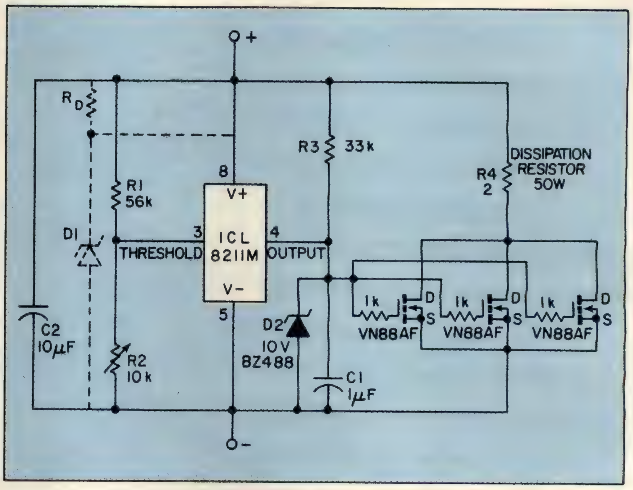
To prevent oscillation, the VMOS transistor leads should be kept short. If short leads are impractical, a ferrite bead placed around each gate lead or a small resistor in series with each gate lead will prevent oscillation. The ferrite beads or resistors must be physically close to the gates.

Anibal Traca de Almeida, Departamento de Engenharia Electrotécnica, Universidade de Coimbra, 3000 Coimbra, Portugal.

CIRCLE NO. 315



1. A solar power supply used to operate *electrical equipment* in remote places uses a shunt voltage regulator and Schottky-barrier blocking diode for maximum efficiency.



2. The circuitry for the shunt regulator of Fig. 1 is for a 5-A, 12-V system. The ICL 8211M detector chip consumes less than 1 mA at threshold voltages below its 1.15 V internal reference.

Winner for January 18, 1980
"Bar-graph Chip Lights LEDs in Series; Minimizes Current Drain for Displays"

Robert A. Pease, Staff Scientist
National Semiconductor Corp.
2900 Semiconductor Dr., Santa Clara, CA 95051

Send us your ideas for Design.
Submit a description of an important new circuit idea or design technique exclusively to ELECTRONIC DESIGN. You will receive $20 for each published idea, $30 more if your idea is voted best-of-issue by our readers. Best-of-issue winners become eligible for the annual award of $1000.

Protect electronic and electrical circuitry.

Let us help you find your magnetic circuit breaker

AIRPAX magnetic circuit breakers are available in so many sizes, capacities and models, you're bound to find exactly what you need with just one phone call to us.

Some models carry up to 600Vac, others up to 125Vdc. We've got models with ratings from milliamps to 100 amps. Choose from mil-spec, UL-listed, UL-recognized, CSA-certified, or SEV-approved models.

We also offer a wide range of sizes. For easy one-hole mounting, we can pack a lot of protection into one cubic inch.

Interested in aesthetics? Choose from models that feature illuminated rocker, colored paddle or baton handles. Just right for front-panel design.

In a hurry? Ask for our "hotline." Use it when you need prototypes and we'll get them to you within two weeks.

Whether you're specifying your first circuit breaker or you're interested in a custom-engineered design for an "impossible" application, you'll get the help you need from AIRPAX.

Circle our number on the Reader Service Card, write us at Woods Road, Cambridge MD 21613 or call us at (301) 228-4600 and we'll send you our new short form catalog.

The choice is yours.

AIRPAX®

NORTH AMERICAN PHILIPS CONTROLS CORP.

Cambridge Division

CIRCLE NO. 91 FOR IMMEDIATE NEED
CIRCLE NO. 92 FOR REFERENCE ONLY

Two New Winners

Take the lead with Intel's two new 4-bit wide fast static RAMs, our 45ns 2149H and our 55ns 2148H. Either way, you win.

2148H/2149H 1K x 4 STATIC RAMs

Part Number	Address Access Time (t_{AA})	Chip Select Access Time (t_{ACS})	Current Active/Stby
2149H-2	45ns	20ns	180mA
2149H-3	55ns	25ns	180mA
2149HL-3	55ns	25ns	125mA
2149H	70ns	30ns	180mA
2149HL	70ns	30ns	125mA
2148H-3	55ns	55ns	180mA/30mA
2148HL-3	55ns	55ns	125mA/20mA
2148H	70ns	70ns	180mA/30mA
2148HL	70ns	70ns	125mA/20mA

There's a fast new pace in wide-word memory, and Intel's two new 1Kx4-bit static RAMs are way out in front. Introducing the high speed, lower power 2148H and the fast chip select 2149H. They're both products of Intel's HMOS II technology and both are high performance descendants of our industry standard 4K x 1-bit 2147H. Best of all, Intel's track record in static RAMs assures you of the quality, reliability, economy and delivery you need for today's competitive system designs.

Fast break for wide-word designs

Designers of high performance writeable control store, cache, buffer and bit slice processor memories will appreciate both these new 4-bit-wide devices. Intel's 2149H delivers the fastest response ever in a TTL-compatible 1Kx4 — 45ns maximum access with 20ns chip select. It's the logical, high performance upgrade from 1K designs, delivering higher density, lower power and a lower parts count.

For power sensitive applications, use the 55ns 2148H. Like the 2147H, the 2148H provides automatic power down on chip deselection. With maximum power consumption as low as 125mA active/20mA standby.

Both the 2148H and 2149H are 18-pin, 5-volt devices, so you're totally compatible with memories like our 1Kx4 industry standard 2114A and 2148 RAMs. Whichever of these new fast statics you choose, you're sure to improve performance: higher speeds, lower power, and simpler designs.

HMOS II for the competitive edge

For years, Intel's HMOS* technology has produced high performance, highly reliable 1K and 4K RAMs. Today, over 50 Intel® HMOS static RAMs give system designers the largest selection of microprocessor and main memory components in the industry. We've already delivered over 18 million of these producible, field-proven HMOS devices, including our industry standard microprocessor, the 8086. Now HMOS II* has arrived, delivering even higher performance, and reliability statistics just as impressive as HMOS.

Pull ahead today

Intel's new 2148H and 2149H are in volume production and on distributor shelves today. So are data sheets and our new HMOS II Reliability Report, #RR26. To get a head start on your competition, contact your local Intel sales office or distributor. Or write Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051. Or call (408) 987-8080.

intel® delivers.

Europe: Intel International, Brussels, Belgium. Japan: Intel Japan, Tokyo. United States and Canadian distributors: Alliance, Almac/Stroum, Arrow Electronics, Avnet Electronics, Component Specialties, Hamilton/Avnet, Hamilton/Electro Sales, Harvey, Industrial Components, Pioneer, L.A. Varah, Wyle Distribution Group, Zentronics.

*HMOS and HMOS II are patented processes of Intel Corporation.

See us at NCC at Booth #1354-60

CIRCLE NO. 93

Our 1800 series keeps expanding: RCA introduces a multiply/divide unit for only $36 (1 K+).

Our new low-cost CMOS multiply/divide unit, the CDP1855, is another good reason to consider the RCA 1800 series of microprocessors and memories for your designs.

The new CDP1855 can increase your computation speed. By over 500 times if you are using our 1802 microprocessor.

And your design time will speed up too. Because with the 1855 less software is required.

Here are even more reasons to choose our 1800 series.

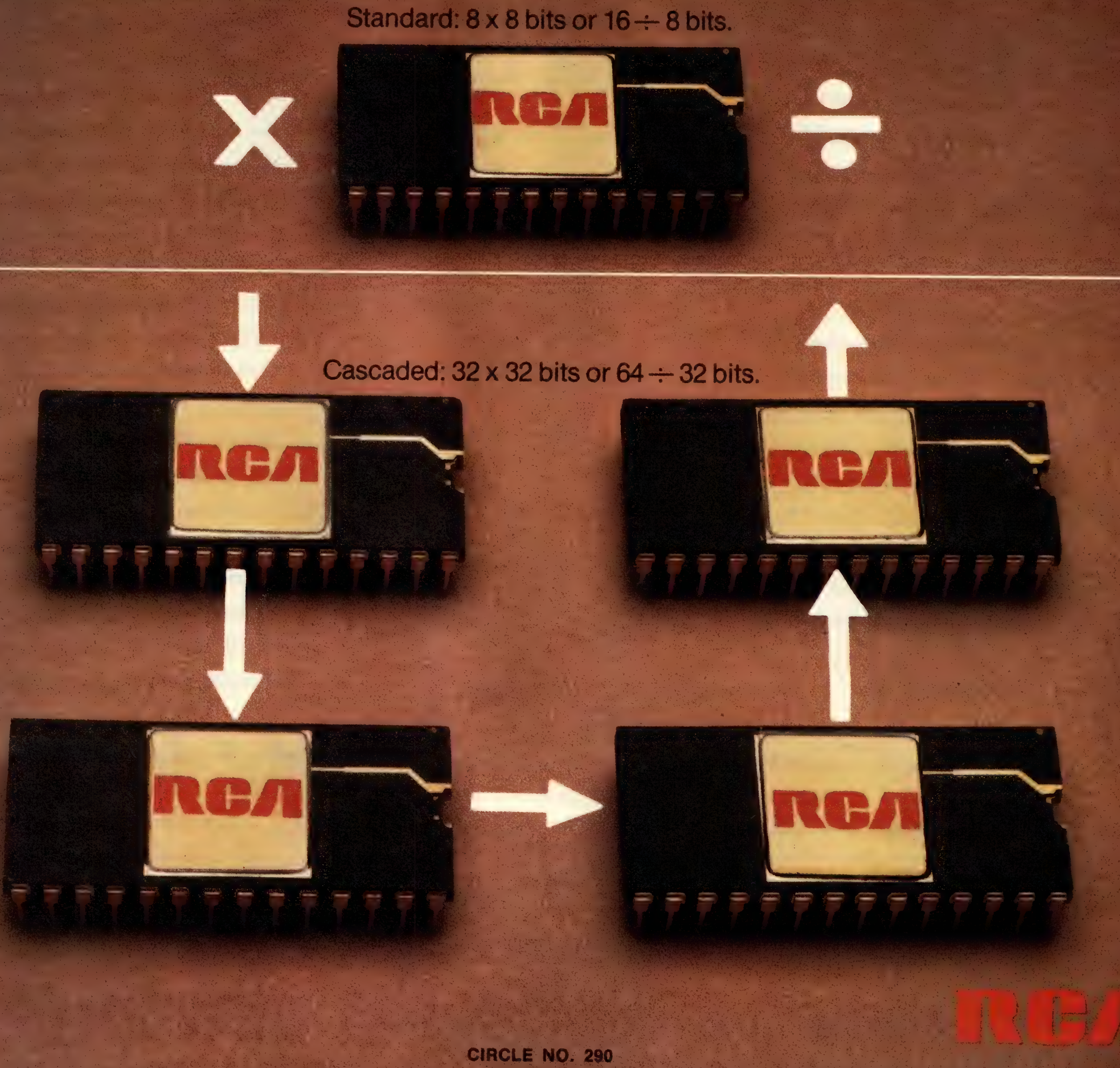
We've also added the CDP1851 interface I/O with 20 bit-programmable I/O lines.

Plus these three new latch/decoder interfaces, CDP1866, CDP1867 and CDP1868.

Equally important, the entire RCA 1800 series offers the CMOS advantages: low power consumption, wide temperature range, and wide voltage tolerance.

For more information, contact your local RCA Solid State Distributor.

Or contact RCA Solid State headquarters in Somerville, New Jersey. Brussels, Belgium. Tokyo, Japan.


Standard: 8 x 8 bits or 16 ÷ 8 bits.
×
RCA
÷
Cascaded: 32 x 32 bits or 64 ÷ 32 bits.
RCA
RCA
RCA
RCA

RCA

CIRCLE NO. 290

The uninterruptible power supply keeps utility line problems from affecting computer systems. A protection level of 100% is ideal, but economy, expected outage time and other variables may allow a lower level.

Focus on UPS systems: They keep the power flowing

Against a background of power disruptions that can destroy the operation of a computer system, the uninterruptible power supply stands out—if only for the promise in its name. UPS systems vary in the protection they offer. A true UPS can handle power outages to some degree; a transformer cannot. After that, the level of performance from different UPS systems appears so similar that other important factors must come to the fore: cost, power output, ability to handle frequency variations and transients, and energy efficiency.

The word uninterruptible covers a multitude of power problems: fast power dropouts lasting milliseconds and long-term blackouts lasting hours or days; overvoltages, from quick power spikes to long-term high-voltage levels; quick voltage dips and long-term voltage lows. Some power systems can handle no more than 10% of these problems; others handle all of them. This substantial difference in performance accompanies an equally substantial difference in cost. However, many computer applications cannot permit even one crash per month; the average number of power incidents monthly in a study came closer to 128 (see Table 1). In such situations, even a small amount of additional protection from a UPS will more than justify its increased cost.

Transformers vs UPS systems

Isolation transformers eliminate common-mode line transients but offer no protection against under and overvoltages, which occur just as often. SCR-tap-controlled transformers are too slow to catch 54% of voltage problems; ferroresonant units miss 62%. Only UPS systems with an engine generator can overcome all power problems (see Table 2).

Although UPS systems as a group handle 99 to 100% of power problems, they do show substantial differences in performance. The relatively low-cost motor-generator is especially reliable for momentary outages or long-term brown-outs in the 100 to 300-kVA range.

The worst-case utility brownout is considered to be 20 to 25% drop below the nominal line level; some manufacturers of large mainframe computers report that their equipment can operate satisfactorily though a half-cycle drop of as much as 30% or a total outage of 20 μs.

Atlas Energy System's motor-generator UPS will hold its output within ±1%, even when the input drops continuously by 20 to 25%. If the input were to drop to 35% of nominal, the output would stay within ±1% for at least two minutes. On a total loss of input, the system's mechanical inertia

Being tested prior to shipment, this 100-kVA UPS system is the latest addition to Sola's product line. Because of an advanced pulse-width-modulation technique, the unit achieves an average efficiency of 90%.

Morris Grossman, Senior Editor

can carry the load for 200 to 500 ms, which will be enough for 22 percent of all outages, according to the study.

Moreover, the motor-generator delivers a "pure" sine wave, free of destructive surges and dips. It also offers a clean shutdown and easy restart, it should power fail for more than 0.5 seconds (or 30 power cycles at 60 Hz), and efficiencies run high—close to 90% especially near full load.

The energy efficiency of a UPS can save—or cost—the buyer thousands of dollars over a year. In its procurement policy, the federal government has begun to express its concern over energy conservation by exacting a penalty for UPS systems that fall below specification and giving a reward for units that exceed them. Efficiencies at partial load can be poor, even when efficiencies at full load are excellent; some systems operate at maximum efficiency at a given load and deteriorate seriously with variations from that load.

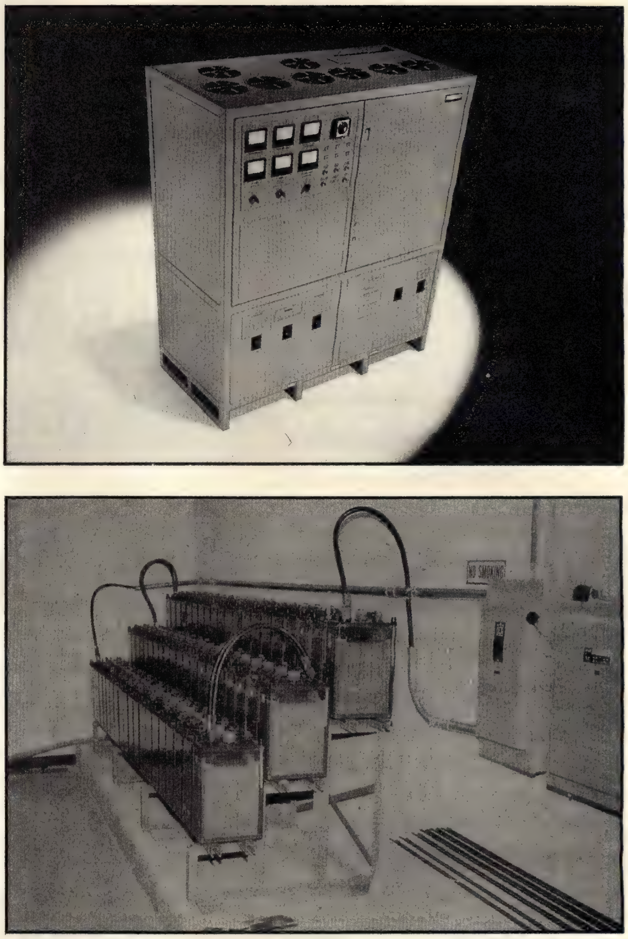
One small unit that achieves 90% average efficiency in high-kVA ratings is the newest UPS in Sola's product line. The 100 kVA unit gets its efficiency from an advanced pulse-width modulation technique in its static inverter circuit.

Power outages that last minutes or even hours demand a battery-supported solid-state UPS. The increase in protection is about 0.8%, according to Table 1. A typical battery-supported UPS in the 0.5 to 10-kVA range can carry the full load for 15 to 30 minutes. For longer outages or power ratings greater than 10 kVA, the addition of a diesel engine often is more economical than adding a larger battery bank. The large battery bank needed to handle even two or three hours of power carryover can cost far more than the rest of the UPS equipment.

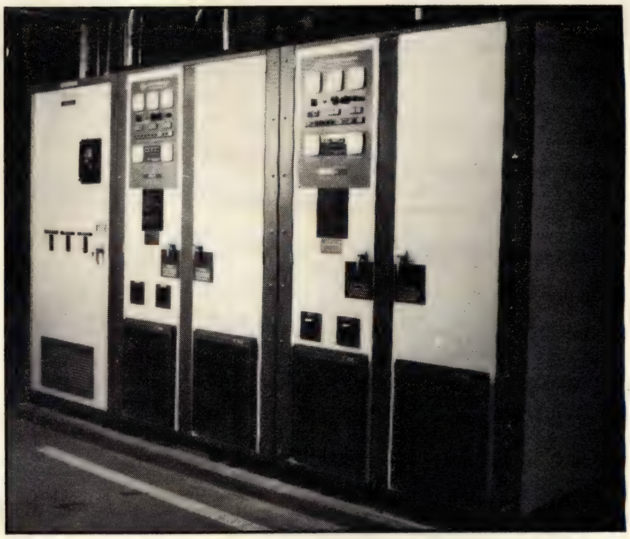
Most power outages, however, last less than five minutes; and most systems have power outputs well within the range best handled by battery-backup banks. Indeed, battery backups are now available that can deliver very large power outputs.

International Power Machines Corp. offers a 50/60-Hz front-access static-inverter UPS (Fig. 1) in 30 to 600-kVA sizes. With battery-backup, it can carry a critical load for 15 to 30 minutes (depending on the battery size). If an outage lasts for more than 10 minutes, a margin of time is available for an orderly shutdown: completing computations in progress, safely storing data and advising remote terminals of a pending shutdown.

In its fifth generation from Power Systems and Controls, the Series S475 (415-Hz) is available in 75-kVA modules (Fig. 2); the Series S600 (50/60-Hz) comes in 40 to 375-kVA modules. Both solid-state UPS units employ a pulse-width-modulated static inverter. True paralleling can be achieved without



1. A typical 50/60-HZ front-access static-inverter UPS (top), which comes in 30-to-600-kVA sizes from International Power Machines, together with a battery backup (bottom), offers excellent insurance against power-line outages; it can carry a critical load for up to 30 minutes, depending on the size of the battery.



2. Employing a pulse-width-modulated static inverter, the Series S475 50/60-Hz solid-state UPS made by Power Systems and Controls comes in 75-kVA modules. The company's Series S600 comes as 40-to-375-kVA modules.

Table 1. Incidence of power problems over three years*

Power problems	Total incidents	Number of incidents corrected					
		Transformers			UPS systems		
		Isolation	SCR-tap	Ferro-resonant	Motor-generator	Static battery	Static battery/ diesel
Undervoltages	1569	0	605	737	1559	1569	1569
Overvoltages	103	0	33	34	103	103	103
Outages	65	0	0	0	14	57	65
Transients, common mode	1676	1676	0	0	1676	1676	1676
Transients, normal	2831	0	0	0	2831	2831	2831
Total incidents	6244	1676	638	771	6183	6236	6244
Power protection offered		27%	10%	12%	99%	99.8%	100%

*Study done by George Allen & Donald Segal of IBM, during 109 monitor-months of data gathering at 29 locations.

Courtesy of Atlas Energy Systems

master oscillators and without paralleling analog signals. Each unit contains a crystal-controlled oscillator in a free-running mode that can automatically home in on other units in the system.

UPS systems must keep their output frequency variation within the 60 Hz ±3% that most computers can tolerate. Crystal control in UPS systems can easily maintain the frequency within 60 ±1 Hz. For power ratings to 25 kVA, the E-PAC series of Instrument and Control System provides a frequency of 60 Hz ±0.5%. The units can supply three-phase outputs.

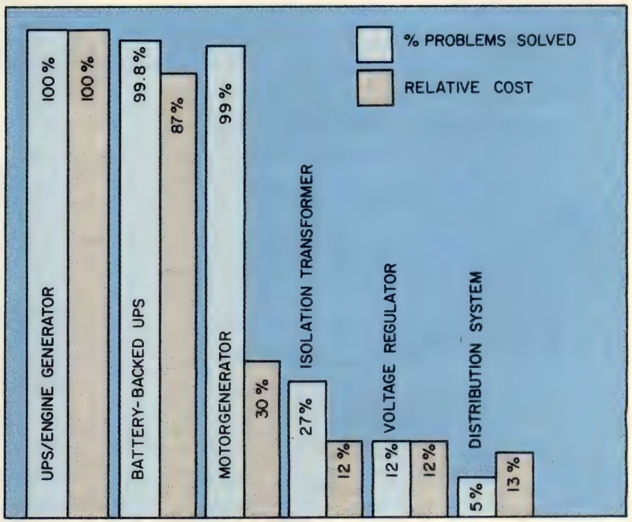
The load of the system will dictate whether a UPS needs to be single phase or three phase. Because they have fewer parts, single-phase units are simpler and cheaper. When three-phase power is needed, the UPS must meet the degree of imbalance actually created by the load and supply the load configuration (either delta or wye) required. Clary Corporation makes single-phase units for 750 VA to 10 kVA and three-phase UPS units for up to 15 kVA.

Small UPS systems, too

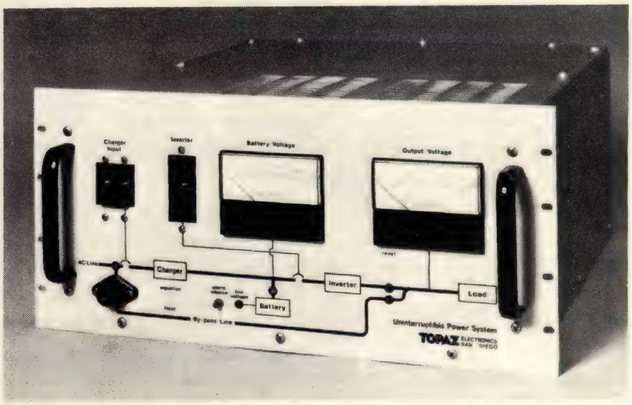
At the other end of size range, Sinclair Scientific has a small UPS unit for portable or laboratory use that supplies 100 VA (150 VA intermittent) at 115 V, 60 ±1/4 Hz. When the line is interrupted, it automatically changes over to an internal sealed battery that can carry a 60-VA load for 1 hour; it needs 8 hours to recharge fully. External batteries (12 V), such as those used in automobile applications, can be added as needed to extend the backup time.

To keep a system free from transients, a floating configuration is the best choice for a UPS unit (see "A float-type UPS: How it works"). Troublesome transients can occur when a UPS must switch from

Table 2. Power problems solved vs relative cost



COURTESY OF ATLAS ENGINEERING SYSTEMS



3. Small UPS systems, like this one from Topaz, can handle power needs to about 0.5 kVA. In general, a small UPS depends on an external battery to take over should the power line fail.

A float-type UPS: How it works

To take full advantage of the isolating and regulating capabilities of a battery-backed uninterruptible power supply, the float-type configuration must be used. The basic UPS consists of a rectifier/battery charger, a dc-to-ac power inverter, and a battery bank.

Under normal conditions, the commercial ac line delivers power to the rectifier/battery charger, and the battery bank is maintained fully charged in a "float" condition (a). The inverter, also receiving dc power from the rectifier/charger delivers regulated conditioned ac to critical loads via an automatic, or sometimes manual, transfer switch.

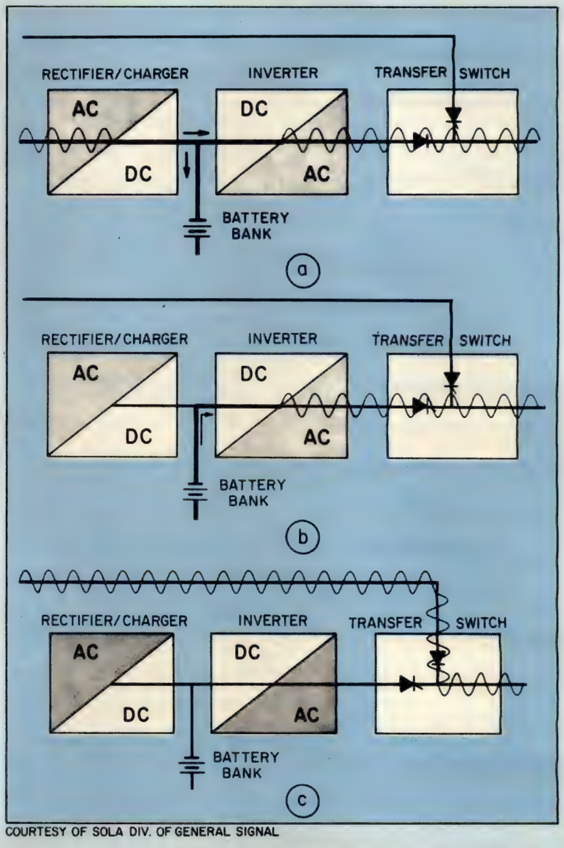
If the ac input line fails (blackout) or drops below normal levels (brownout), dc will continue to be supplied to the inverter from the charged battery bank (b). If the UPS is overloaded or malfunctions, the bypass switch can transfer the load directly to the commercial power mains (c).

When the power source is not subject to inordinate transient activity, or when the equipment is sufficiently filtered to tolerate them, considerable cost can be saved by taking power primarily from the power mains. Then, since the UPS now serves only as a backup, the rectifier/charger can be a much smaller unit—it need supply only the battery recharge or smaller floating current, not the full load. In addition, the battery-charger current need not be highly regulated or filtered.

For an inexpensive power-loss backup system, a manual break-before-make device (if a break in power is permissible) can handle the switchover from line power to inverter output. But usually a solid-state power-loss sensing circuit, called a state switcher, is employed to accomplish the transfer automatically, and as quickly as possible. Solid-state switchover circuits—generally referred to as static-transfer, or bypass, switches—can be designed to take up high in-rush (or even fault) currents.

Power lines also have power-surge limitations. The UPS itself can zoom the line current up when power returns after an outage. Then, if a breaker trips and the battery is low, the purpose of the UPS has been defeated—the load goes unserviced. Current surges can even be large enough to damage expensive equipment. Therefore, the UPS (at least in the larger sizes) should include means for "walking-in" the power gradually to prevent destructive surges.

Many types of batteries are available for UPS systems: high-quality lead calcium, lead antimony, nickel-cadmium and low-cost, common lead-acid batteries (the newer sealed types require little maintenance or attention). In small systems, about 500 VA or less, even gel-type batteries can work.



COURTESY OF SOLA DIV. OF GENERAL SIGNAL

The batteries can have an outage carry-over capacity for as little as five minutes or, in remote locations, for several hours—but about 30 minutes is typical. The battery recharge rates are generally "standardized" for 8, 12 or 24 hours.

Typically, a 10-kVA float-type UPS will include an ac/dc rectifier-charger circuit to supply about 115 A dc—about 15 A to charge the battery bank from full discharge and 100 A to run a solid-state dc/ac inverter. If the battery is sized for 30 minutes of support, delivering about 100 A, a 50-A-hr battery capacity is needed. It can be recharged in under 5 hours by the 15-A recharge rate. Thereafter, the fully charged battery bank needs only between a 1 and 5-A float to maintain full charge, depending on the type and condition of the battery bank.

its inverter to the line if the inverter fails—or switch from the line to the UPS if the line fails, which is the more common situation. Therefore, the switchover transient behavior of a UPS system should be checked very carefully.

No UPS is truly uninterruptible without a static transfer switch to transfer from inverter to line or vice versa. Solid-state switches vary in transfer speed, from microseconds to 0.25 cycles; electromechanical switches take 50 to 100 ms.

Small systems (up to 0.5 kVA) from Topaz Electronics *(Fig. 3)* contain a solid-state static switch that operates on a make-before-break basis. It takes less than 4 ms to transfer the load from the inverter to the ac line. For less critical applications, the system comes with an electromechanical transfer switch that transfers the load in less than 50 ms.

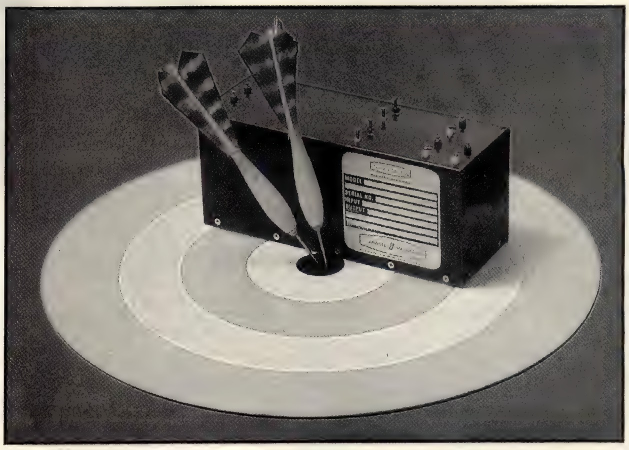
Small UPS systems can even supply multiple regulated dc outputs. For instance, a UPS series from Semiconductor Circuits delivers regulated dc outputs of ±12 or ±15 V (at currents up to ±300 mA) and +5 V (at a current of up to 15 A) for powering logic circuits. At the same time, the unit can float a 12 or 24-V backup battery, which is supplied by the user. If the line fails, the supply's primary line-power circuit disconnects itself, and the backup battery becomes the power source.

Similarly, Arnold Magnetics also offers UPS units having multiple regulated dc outputs. Switchover time is minimal if the main ac power is lost or interrupted. Before loss of power, a digital power-failure signal is generated to trigger the storage of data in memory (Fig. 4).

For a minimum-power system, Stevens-Arnold's UPS-2708B provides backup just for MOS memory and refresh logic that is independent of an ac power outage. Instead of kilowatts and kilobucks for total UPS power, only the bare essentials are kept on during an outage or standby shutdown, which can last for 1 to 3 hours.

But whether the power needs are large or small, the power line should be monitored before a UPS is chosen to help specify the proper UPS; and then after the chosen UPS is installed, to make sure that it is working as anticipated. Franklin Electric has a power-line disturbance monitor that provides a hard-copy report on the nature and frequency of variations in utility power current.

Some of the UPS units produced by Deltec include their own status-and-control panel that constantly monitors UPS performance. When an automatic transfer to a bypass source of ac power occurs, status indicators pinpoint the problem. They also indicate an automatic return transfer to the inverter output if, for example, an overcurrent condition clears up after the original transfer.□



4. This dual-input UPS unit (the NHX series) from Arnold Magnetics allows the user to specify any two input voltages to drive up to 10 isolated dc outputs at 400 VA maximum. Switchover from one input to the other can be automatic or controlled externally.

Need more information?

For further information on uninterruptible power supplies, readers may consult the manufacturers who participated in this special report by circling the appropriate numbers on the reader service card. Every manufacturer, does not make every size or type of UPS. More information on specific vendors and their lines may be found in ELECTRONIC DESIGN'S GOLD BOOK.

Arnold Magnetics Corp., 11520 W. Jefferson, Culver City, CA 90230. (213) 870-7014. **CIRCLE NO. 451**

Atlas Energy Systems, 9457 Rush St. South, El Monte, CA 91733. (213) 575-0755. **CIRCLE NO. 452**

Clary Corp., Precision Instrument Div., 320 W. Clary Ave., San Gabriel, CA 91776. (213) 287-6111. **CIRCLE NO. 453**

Computer Power Inc., 124 W. Main St., High Bridge, NJ 08829. (201) 735-8000. **CIRCLE NO. 454**

Converter Concepts Inc., 435 S. Main St., Pardeeville, WI 53954. (608) 429-2144. **CIRCLE NO. 455**

Data Power, Memory UPS Div., P.O. Box 1290, Framingham, MA 01701. (617) 653-2021. **CIRCLE NO. 456**

Deltec Corp., 980 Buencs Ave., San Diego, CA 92110. (714) 275-1331. **CIRCLE NO. 457**

Franklin Electric Co., Programmed Power Div., 995 Benicia Ave., Sunnyvale, CA 94086. (408) 245-8900. **CIRCLE NO. 458**

Gulton Industries Inc., Engineered Magnetics Div., 13041 Cerise Ave., Hawthorne, CA 90250. (213) 679-0111. **CIRCLE NO. 459**

HDL Research Laboratory Inc., 8381 Westview, Houston, TX 77055. (713) 464-6050. **CIRCLE NO. 460**

Instrument and Control System, Inc., Electro-pac Div., 520 Interstate Rd., Addison, IL 60101. (312) 543-6200. **CIRCLE NO. 461**

International Power Machines Corp., 3328 Executive Blvd., Mesquite, TX 75149. (214) 288-7501. **CIRCLE NO. 462**

Power Systems & Controls Inc., P.O. Box 27306, Richmond, VA 23261. (804) 355-2803. **CIRCLE NO. 463**

Semiconductor Circuits Inc., Power Sources, 218 River St., Haverhill, MA 01830. (617) 373-9104. **CIRCLE NO. 464**

Sinclair Scientific Inc., 1101 E. Ash Ave., Fullerton, CA 92631. (714) 870-0912. **CIRCLE NO. 465**

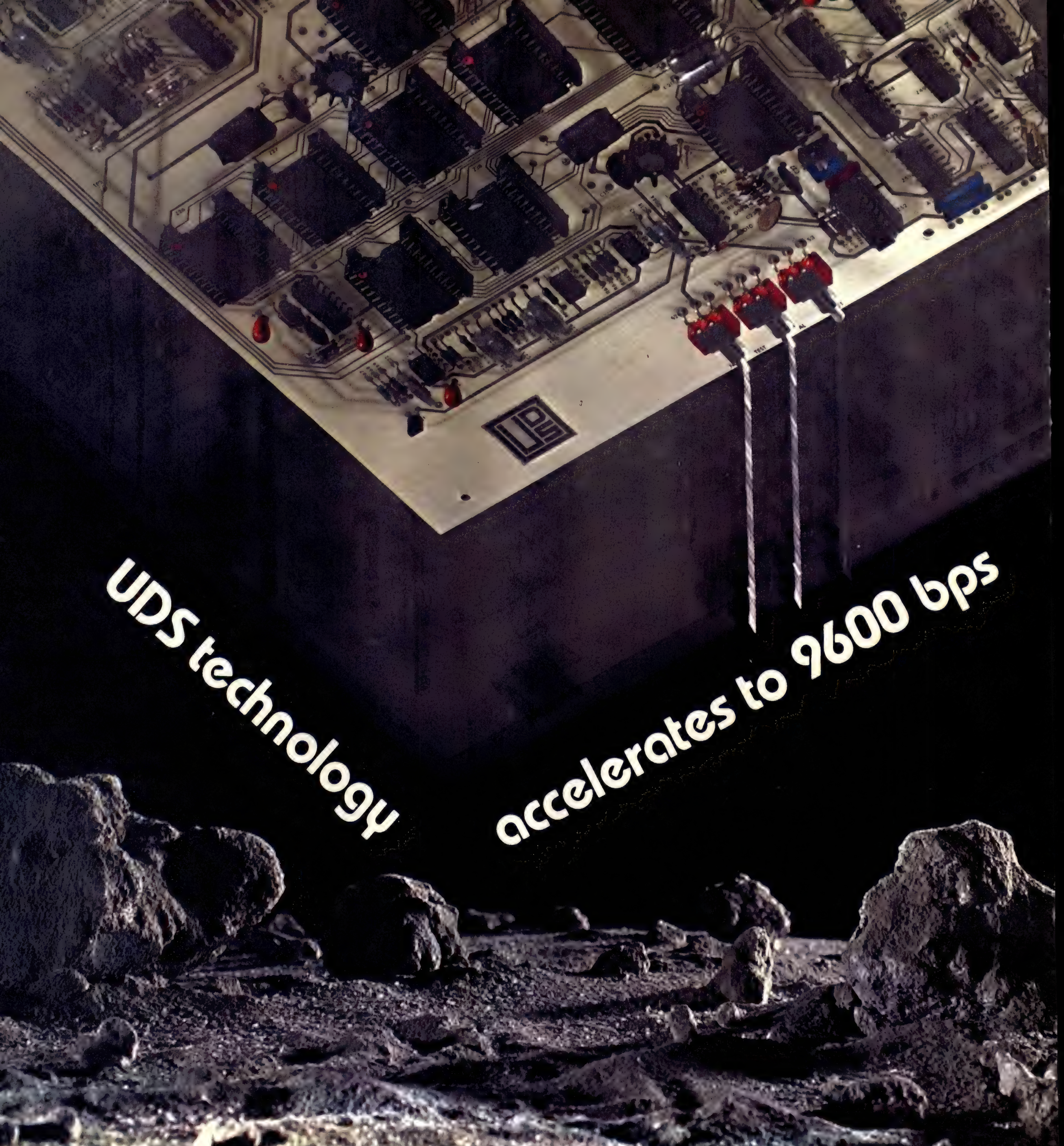
Solidstate Controls Inc., 600 Oakland Park Ave., Columbus, OH 43214. (614) 263-1886. **CIRCLE NO. 466**

Sola (General Signal) 1717 Busse Rd., Elk Grove Village, IL 60007. (312) 439-2800. **CIRCLE NO. 467**

Stevens-Arnold Inc., DC/DC Converter Power Supply, 7 Elkins St., South Boston, MA 02127. (617) 268-1170. **CIRCLE NO. 468**

Sun Technology, Inc., Box 210, New Durham, NH 03855. (603) 859-7110. **CIRCLE NO. 469**

Topaz Electronics, 3855 Ruffin Rd., San Diego, CA 92123. (714) 279-0831. **CIRCLE NO. 470**



The accelerating growth in modem technology at Universal Data Systems has now produced the Company's first 9600 bps unit on a super-compact OEM board. Occupying about 100 square inches of PCB space, this microprocessor LSI modem offers dramatic space savings for designers who wish to package data sets internally in microcomputers, minicomputers or interactive terminals. The traditional UDS economy and reliability are inherent in the new 9600 bps modem.

Contact UDS for complete technical details, or phone your UDS representative. Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone: 205/837-8100.

"Confidence in Communications"

Universal Data Systems

Member IDCMA

DISTRICT OFFICES: **Summit**, NJ, 201/522-0025 • **Blue Bell**, PA, 215/643-2336 • **Atlanta**, 404/952-3463
Chicago, 312/441-7450 • **Dallas**, 214/385-0426 • **Santa Ana**, 714/972-4619 • **Sunnyvale**, 408/738-0433

See us at NCC Booth Nos. 1700, 1701, 1703, 1800

CIRCLE NO. 95

Created by Dayner/Hall, Inc., Winter Park, Florida

146-1401

KEPCO/TDK

switching power supplies

COVER THE WATERFRONT

CHOOSE SINGLE OR MULTI-OUTPUT SWITCHERS, OPEN FRAME OR FULLY SHIELDED, FROM 10 TO 300 WATTS

Here are the compact, high reliability switching power supplies for your most demanding applications. For the shorebound, the a-c to d-c models work nicely from 115/230V a-c mains. When you're running offshore, on batteries, you'll appreciate the efficiency of our seaworthy d-c to d-c converters.

Like a sail on the turbulent sea, Kepco's stabilizers smooth the most restless power sources to provide calm, adjustable, voltages, with hardly a ripple.

KEPCO®

131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352 U.S.A. • (212) 461-7000 • TWX #710-582-2631 • Cable: KEPCOPOWER NEWYORK

KEPCO/TDK SWITCHING POWER SUPPLIES

One of the best technologies for stabilizing voltage in modular power supplies is high frequency switching. The "off line" technique used in Kepco/TDK switchers first rectifies and filters the incoming a-c mains. The d-c is then converted to a high frequency square wave at about 25 KHz. Before being passed through a special high frequency ferrite transformer, the square wave is width-modulated to impress the information needed to close a stabilization feedback loop. On the secondary side of the transformer, the high frequency square wave is re-rectified and filtered of its high frequency components to become d-c at the desired level.

The efficiency of such circuits is very high. Additionally, the components are quite small and light in weight. Advanced TDK ferrites operate with significantly lower losses than do competitive units making these power supplies run perceptibly cooler. This is particularly significant since the thermal coupling of power transformers to the outside world is poor. Dissipation in the power transformer and the output choke is a major source of internal heating in many competitive models.

Kepco/TDK Switching Power Supplies are available in four design groups:

RMK/RMX	Single output a-c to d-c voltage stabilizers
RMD	Single output d-c to d-c converters
RMT/RXT	Triple output a-c to d-c voltage stabilizers
MP/CMP	Miniature a-c to d-c voltage stabilizers MP: single output; CMP: dual output

RMK

115V a-c input
(145V d-c)

RMK/RMX produce a single stabilized d-c output using a high frequency modulated inverter. The input is rectified and filtered, then "switched" at 25 kHz to pass through a miniature ferrite transformer, where it is rectified and filtered again to become the d-c output. Stabilization and control is effected by modulating the pulse width of the switching circuit. An adjustable, rectangular, current limit circuit provides overload protection, an adjustable squelch-type overvoltage circuit protects the load.

RMX

115/230V a-c input selectable
(290V d-c)

Size S

RMK	RMX	VOLTS	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
RMK 05-S	—	3.5–5.5	6.9	6.4	6.0	4.2	2.4
RMK 09-S	—	6.3–9.9	4.1	3.7	3.3	2.3	1.3
RMK 12-S	—	8.4–13.2	3.0	2.7	2.5	1.7	1.0
RMK 15-S	—	10.5–16.5	2.4	2.2	2.0	1.4	0.8
RMK 24-S	—	16.8–26.4	1.6	1.4	1.3	0.9	0.5

Size A

RMK	RMX	VOLTS	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
RMK 05–A	RMX 05–A	3.5–5.5	12.0	10.8	10.0	8.3	5.0
RMK 09–A	RMX 09–A	6.3–9.9	7.6	6.8	6.0	5.2	2.7
RMK 12–A	RMX 12–A	8.4–13.2	6.3	5.6	5.0	4.3	2.0
RMK 15–A	RMX 15–A	10.5–16.5	5.0	4.5	4.0	3.4	1.7
RMK 24–A	RMX 24–A	16.8–26.4	3.2	2.8	2.5	2.2	1.0
RMK 28–A	RMX 28–A	19.6–30.8	2.65	2.40	2.15	1.90	0.90

Size B

RMK	RMX	VOLTS	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
RMK 05–B	RMX 05–B	3.5–5.5	36.0	34.0	26.0	17.0	9.0
RMK 09–B	RMX 09–B	6.3–9.9	20.0	17.0	15.0	10.0	5.2
RMK 12–B	RMX 12–B	8.4–13.2	16.6	15.0	12.0	8.0	4.2
RMK 15–B	RMX 15–B	10.5–16.5	13.3	13.3	10.2	6.2	3.3
RMK 24–B	RMX 24–B	16.8–26.4	8.5	8.5	7.5	4.7	2.3
RMK 28–B	RMX 28–B	19.6–30.8	7.2	6.8	6.4	4.6	2.0

Size C

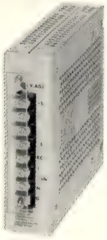
RMK	RMX	VOLTS	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
RMK 05–C	RMX 05–C	3.5–5.5	40.0	38.0	30.0	21.5	14.0
RMK 09–C	RMX 09–C	6.3–9.9	22.0	22.0	17.2	12.5	7.7
RMK 12–C	RMX 12–C	8.4–13.2	17.0	17.0	14.6	10.5	5.8
RMK 15–C	RMX 15–C	10.5–16.5	14.0	14.0	12.3	8.3	4.7
RMK 24–C	RMX 24–C	16.8–26.4	9.0	9.0	8.0	5.5	3.0
RMK 28–C	RMX 28–C	19.6–30.8	7.7	7.7	6.8	4.7	2.5

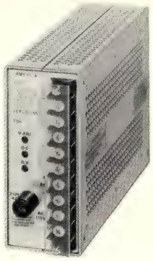
Size N

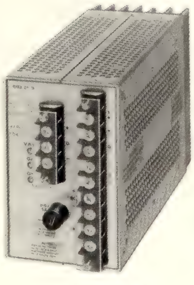
RMK	RMX	VOLTS	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
—	RMX 05–N	3.5–5.5	54.0	49.5	45.0	31.5	15.0
—	RMX 09–N	6.3–9.9	30.0	27.5	25.0	17.5	8.7
—	RMX 12–N	8.4–13.2	22.8	20.9	19.0	13.3	6.6
—	RMX 15–N	10.5–16.5	18.0	16.5	15.0	10.5	5.2
—	RMX 24–N	16.8–26.4	11.4	10.4	9.5	6.6	3.3
—	RMX 28–N	19.6–30.8	9.6	8.8	8.0	5.6	2.8

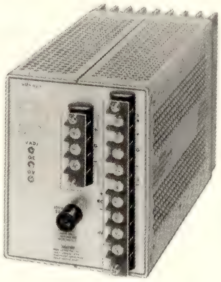
Size D

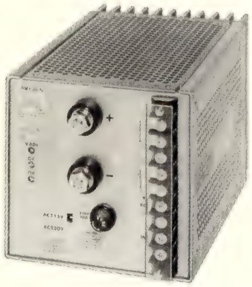
RMK	RMX	VOLTS	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
—	RMX 05–D	3.5–5.5	70.0	70.0	60.0	42.0	30.0
—	RMX 09–D	6.3–9.9	37.0	37.0	32.0	24.0	16.0
—	RMX 12–D	8.4–13.2	32.0	32.0	27.0	19.0	11.0
—	RMX 15–D	10.5–16.5	27.0	27.0	23.0	16.0	9.0
—	RMX 24–D	16.8–26.4	18.0	18.0	16.0	11.0	6.0
—	RMX 28–D	19.6–30.8	15.4	15.4	13.7	9.4	5.1

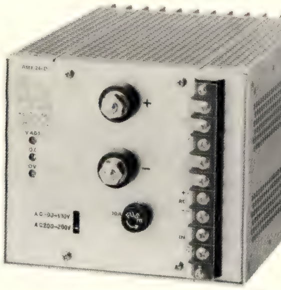

Size S


Size A


Size B


Size C


Size N


Size D

© 1980, KEPCO, INC.-Litho in U.S.A.

Data subject to change without notice.

INPUT CHARACTERISTICS

RMK - a-c input: 100–130V a-c, 47–440 Hz., single phase.
d-c input: 130–170V d-c.

BROWN OUT PROTECTION:
Minimum input voltage: 85Va-c/110Vd-c (typically 80Va-c/105V d-c). Operation is maintained down to this brown-out level with minor degradation in performance (slightly increased ripple, larger load effect, reduced holding time).

RMX - a-c input: Selectable, 100–130V a-c or 200–260V a-c, 47–440 Hz, single phase.
d-c input: 260–340V d-c.

BROWN OUT PROTECTION: Operation is maintained down to 90/180V a-c, (234V d-c) with minor degradation in performance (slightly increased ripple, larger load effect and reduced holding time).

SOFT START: A surge limiting circuit is incorporated to limit the initial turn-on current. A separate logic level on-off circuit is provided in *all* models for no-surge cycling.

EFFICIENCY: The high frequency converter in RMK/RMX stabilizes voltage with minimum losses.

EFFICIENCY	S	A	B	C	N	D
Typical	73%	68%	75%	75%	80%	75%
Minimum	70%	65%	70%	70%	75%	70%

HOLDING TIME: The RMK and RMX store sufficient energy in their filters to sustain the d-c output a minimum of 20 milliseconds (30 milliseconds typically) after source power is lost. This rating is based upon nominal (115V/230V a-c) source voltage and the +50°C loading level.

EMI:

Conducted: RMK/RMX switching power supplies are fitted with EMI suppression devices. All models are equipped with built-in LC input filters to attenuate the noise conducted back down the power line. Output terminals are fitted with good high frequency by-pass capacitors. Accessory filters may be used between the power supply and the source power line to further attenuate the conducted EMI.

Radiated: All units are fully enclosed in grounded metal nclosures to minimize radiation. Units meet the requirements of VDE 0875/7.71 (level N).

OUTPUT CHARACTERISTICS

OLTAGE ADJUSTMENT RANGE: Output voltage is adjustable hrough a range of −30% to +10% of the nominal setting.

URRENT LIMIT: The output current limit is factory-set to 115% f the +50°C current rating and may be readjusted to 115% of the 30°C and 40°C current ratings. Note: The current limit adjustment s internal in the Size S models.

URRENT-TEMPERATURE RATINGS: Output current is rated on the basis of an average 80°C maximum heat-sink temperature. The ambient temperature ratings are derived for free-air operation ith the cooling fins (Sizes B, C, N and D) oriented vertically and paced ½-inch (1.25 cm) above a plane surface. When moving air or other cooling means are available, the output current rating nay be increased to the +30°C level. The Size S and Size A nodels can be equipped with accessory fins that allow approximately a 10°C shift in the operating temperature. This corresponds to an increased current rating per the model table.

EMOTE ERROR SENSING: Separate terminals allow a -terminal connection between power supply and load. These connections can compensate for voltage drops in the connecting wires up to 0.25 volts per wire for RMK models and up to 0.35 volts per vire for RMX models

ECOVERY CHARACTERISTICS: A step-load change from 0–100% produces less than 2% output excursion (or 0.5V, whichever is greater). Recovery occurs to within 0.5% (or 0.05V, whichever is greater) of the original setting within 1 millisecond (2 milliseconds for the size S models).

REMOTE CONTROL: A TTL compatible logic level signal can be used to turn the power supply on and off. An internal pull-up resistor programs the power supply on in the absence of external signals. This feature can be used for sequencing and for no-surge cycling.

OVERVOLTAGE PROTECTION: An overvoltage sensor shuts down the switching oscillator and reduces the output to zero whenever the output voltage tries to exceed the overvoltage threshold setting. It is reset by turning the source power off and then back on. The setting is fixed (approximately 120%) in "S" models, adjustable in all other models.

STABILIZATION:

STATIC STABILIZATION	RMK-S		RMK-A, -B, -C RMX-A, -B, -C, -N, -D	
	Typ.	Max.	Typ.	Max.
SOURCE EFFECT (min–max):	<0.4%	0.8%	<0.3%	0.6%
LOAD EFFECT (10%–100%):	<0.4%	1.0%	<0.3%	0.6%
TEMPERATURE EFFECT Coefficient per °C:	<0.02%	0.1%	<0.02%	0.1%
Envelope, 0–50°C:	<0.6%	1.0%	<0.4%	0.8%
COMBINED EFFECT For rated changes in source voltage, load current and temperature:	<1.4%	2.8%	<1.0%	2.0%
TIME EFFECT (8-hour drift) Constant source voltage, load and temperature:	<0.02%	0.1%	<0.02%	0.1%
RIPPLE and NOISE rms:	< 7 mV	10 mV	< 5 mV	10 mV
Source component:	<20 mV	50 mV	<10 mV	50 mV
Switching component:	<30 mV	100 mV	<15 mV	50 mV
Spike voltage to 10 MHz:	<70 mV	1% E_0 +50 mV	<50 mV	1% E_0 +50 mV

GENERAL

AMBIENT OPERATING TEMPERATURE RANGE: 0 to +71°C. The model tables specify the maximum current available from each model as a function of ambient temperature. Ratings are based on a maximum heat sink temperature of +80°C. The power supplies may be operated with an external source of moving air at up to the +30°C current rating, provided that the heat sink temperature does not exceed +80°C.

STORAGE TEMPERATURE: −20°C to +75°C

HUMIDITY: 85% RH, non-condensing.

SHOCK and VIBRATION:

Shock: 20g, 3 axes.
11 ms. ±5 ms. pulse duration.
Vibration: 5–10 Hz, 10 mm amplitude, 3 axes.
10–55 Hz, 2g, 3 axes.

WITHSTAND VOLTAGE:

115V a-c models: 1.5 KV a-c for 1 minute, input to chassis or input to output.
115/230V a-c models: 2.5 KV a-c for 1 minute, input to chassis or input to output.

ISOLATION, between output terminals and case: 500V d-c, 100 megohms minimum. Floating output enables plus or minus operation of any power supply. *Note:* Ripple is measured with one output terminal grounded.

SERIES/PARALLEL: RMK/RMX power supplies employ a rectangular current limit (not a foldback or re-entrant type). This means there is no "lockout" problem or start-up problem when two or more units are connected in series or in parallel

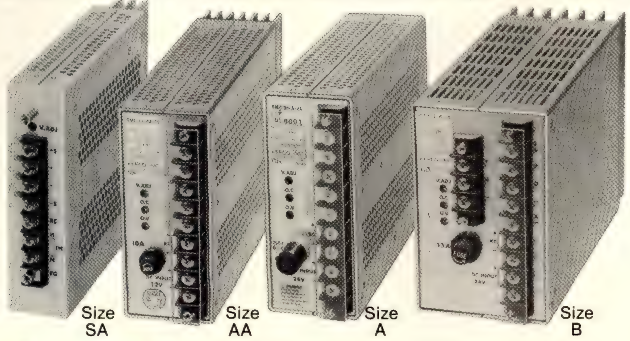
MOUNTING: Tapped 8-32 mounting holes allow these power supplies to be fastened by any of the four major surfaces.

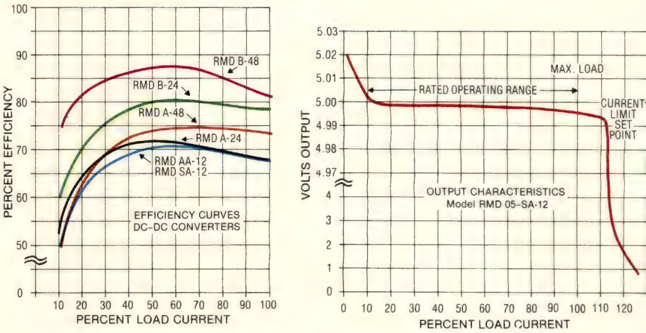
The RMK/RMX models can be rack mounted in either RA–39 or RA–40 to form combination power supply systems.

FINISH: Phosphate treated aluminum.

KEPCO/TDK RMD d-c to d-c converters

The KEPCO/TDK series RMD are d-c input, isolated voltage stabilizers. Standard inputs are 12V, 24V, and 48V d-c. Outputs are 5V, 9V, 12V, 15V, 24V and 28V. For other input and output ratings consult factory.





TYPICAL EFFICIENCY & STABILIZATION CURVES

Size SA

MODEL	d-c INPUT VOLTS	OUTPUT VOLTAGE RANGE	OUTPUT CURRENT – AMPS VS. TEMPERATURE				
			30°C	40°C	50°C	60°C	71°C
RMD 05-SA-12	12	3.5-5.5	6.8	6.4	6.0	4.2	2.4
RMD 09-SA-12	12	6.3-9.9	3.8	3.6	3.3	2.3	1.3
RMD 12-SA-12	12	8.4-13.2	2.9	2.7	2.5	1.7	1.0
RMD 15-SA-12	12	10.5-16.5	2.3	2.2	2.0	1.4	0.8
RMD 24-SA-12	12	16.8-26.4	1.5	1.4	1.3	0.9	0.5
RMD 28-SA-12	12	19.6-30.8	1.25	1.2	1.1	0.8	0.43

Size AA

RMD 05-AA-12	12	3.5-5.5	11.5	10.8	10.0	8.0	4.0
RMD 09-AA-12	12	6.3-9.9	6.9	6.5	6.0	4.8	2.4
RMD 12-AA-12	12	8.4-13.2	5.5	5.3	5.0	4.0	2.0
RMD 15-AA-12	12	10.5-16.5	4.4	4.2	4.0	3.2	1.6
RMD 24-AA-12	12	16.8-26.4	2.75	2.6	2.5	2.0	1.0
RMD 28-AA-12	12	19.6-30.8	2.35	2.25	2.15	1.7	1.86

Size A

RMD 05-A-24	24	3.5-5.5	12.0	10.8	10.0	8.3	5.0
RMD 09-A-24	24	6.3-9.9	7.6	6.8	6.0	5.2	2.7
RMD 12-A-24	24	8.4-13.2	6.3	5.6	5.0	4.3	2.0
RMD 15-A-24	24	10.5-16.5	5.0	4.5	4.0	3.4	1.7
RMD 24-A-24	24	16.8-26.4	3.2	2.8	2.5	2.2	1.0
RMD 28-A-24	24	19.6-30.8	2.7	2.4	2.1	1.8	0.8

RMD 05-A-48	48	3.5-5.5	12.0	10.8	10.0	8.3	5.0
RMD 09-A-48	48	6.3-9.9	7.6	6.8	6.0	5.2	2.7
RMD 12-A-48	48	8.4-13.2	6.3	5.6	5.0	4.3	2.0
RMD 15-A-48	48	10.5-16.5	5.0	4.5	4.0	3.4	1.7
RMD 24-A-48	48	16.8-26.4	3.2	2.8	2.5	2.2	1.0
RMD 28-A-48	48	19.6-30.8	2.7	2.4	2.1	1.8	0.8

Size B

RMD 05-B-24	24	3.5-5.5	36.0	34.0	26.0	17.0	9.0
RMD 09-B-24	24	6.3-9.9	20.0	17.0	15.0	10.0	5.2
RMD 12-B-24	24	8.4-13.2	16.6	15.0	12.0	8.0	4.2
RMD 15-B-24	24	10.5-16.5	13.3	13.3	10.2	6.2	3.3
RMD 24-B-24	24	16.8-26.4	8.5	8.5	7.5	4.7	2.3
RMD 28-B-24	24	19.6-30.8	7.2	7.2	6.4	4.0	1.9

RMD 05-B-48	48	3.5-5.5	36.0	34.0	26.0	17.0	9.0
RMD 09-B-48	48	6.3-9.9	20.0	17.0	15.0	10.0	5.2
RMD 12-B-48	48	8.4-13.2	16.6	15.0	12.0	8.0	4.2
RMD 15-B-48	48	10.5-16.5	13.3	13.3	10.2	6.2	3.3
RMD 24-B-48	48	16.8-26.4	8.5	8.5	7.5	4.7	2.3
RMD 28-B-48	48	19.6-30.8	7.2	7.2	6.4	4.0	1.9

SPECIFICATIONS

INPUT CHARACTERISTICS

SOURCE VOLTAGE: "–12": 10V d-c to 15V d-c.
"–24": 20V d-c to 30V d-c.
"–48": 42V d-c to 56V d-c.

REVERSE POLARITY PROTECTION: Built-in.

INPUT CURRENT AND EFFICIENCY:

SIZE	EFFICIENCY		INPUT CURRENT	
	TYP.	MIN.	TYP.	MAX.
SA-12	71%	65%	3.5A	5.5A
AA-12	72%	65%	6.5A	9.5A
A-24	73%	67%	3.5A	5.3A
A-48	73%	67%	1.7A	2.6A
B-24	75%	70%	10.0A	13.0A
B-48	75%	70%	5.0A	6.0A

WITHSTAND VOLTAGE: 1.5 KV a-c for 1 minute, input to chassis or input to output.

ISOLATION: Between output terminals and case: 500 volts d-c, 100 megohms minimum.

EMI:

Conducted: Filters are built into all models to attenuate line-conducted electromagnetic interference to levels that are acceptable for most applications. Accessory filters may be used between the power supply and the source power bus to further attenuate the conducted EMI.

Radiated: RMD power supplies meet the radiated EMI requirements of MIL STD 461 A. Notice 3 method CE03.

OUTPUT CHARACTERISTICS

VOLTAGE ADJUSTMENT RANGE: Output voltage is adjustable through a range of –30% to +10% of the nominal setting. (See tabulated voltage.)

CURRENT/TEMPERATURE RATINGS: Output current is rated as a function of ambient temperature, based on a maximum heat fin temperature of +80°C. When moving air, or other cooling mean are available to carry away the generated heat, the output current rating of the RMD may be increased to the maximum level set by the +30°C rating.

CURRENT LIMIT CHARACTERISTIC: Rectangular limit characteristic, adjustable.

CURRENT ADJUSTMENT RANGE: From 115% of the 30°C current value to lower than the 50°C current rating value.

RECOVERY CHARACTERISTICS: A step load change from 50% to 100% produces less than 2% output excursion (or 0.5V, whichever is greater). Recovery occurs to within 0.5% (or 0.05V. whichever is greater) of the original setting within 1 millisecond for Size A and AA models and 2 milliseconds for the Size L models.

Data subject to change without notice.

STATIC STABILIZATION	Typ.	Max.
SOURCE EFFECT (min-max):	<0.4%	0.8%
LOAD EFFECT (10%-100%):	<0.4%	0.8%
TEMPERATURE EFFECT Coefficient per °C:	<0.01%	0.05%
Envelope, 0-50°C:	<0.2%	0.6%
COMBINED EFFECT For rated changes in source voltage, load current and temperature:	<1.0%	2.2%
TIME EFFECT (8-hour drift) Constant source voltage, load and temperature:	<0.01%	0.05%
RIPPLE and NOISE rms:	< 3 mV	10 mV
Switching component: p-p	<50 mV	100 mV
Spike voltage to 10 MHz: p-p	1% E_0+50 mV	

EMOTE ERROR SENSING: Separate terminals allow a 4-wire connection between power supply and load. These connections can compensate for voltage drops in the connecting wires up to .25 volts per wire.

VERVOLTAGE PROTECTION (adjustable): An overvoltage sen- or shuts down the switching oscillator and reduces the output to ero whenever the output voltage tries to exceed the overvoltage hreshold setting. It is reset by turning the source power input off and then back on.

REMOTE CONTROL: A TTL compatible logic level signal can be used to turn the power supply on in the absence of external signals. This feature can be used for sequencing and for avoiding input current surges during turn-on.

GENERAL

AMBIENT OPERATING TEMPERATURE: 0 to +71°C. The model table specifies the maximum current available versus ambient temperature. These ratings are based upon a maximum heat sink temperature of +80°C.

STORAGE TEMPERATURE: −20°C to +75°C.

HUMIDITY: 85% RH, non-condensing.

SERIES/PARALLEL: RMD Power Supplies employ a rectangular current limit (not a foldback or re-entrant type). There is, therefore, no lockout problem or start-up problem when two or more units are connected in series or in parallel.

SHOCK and VIBRATION:

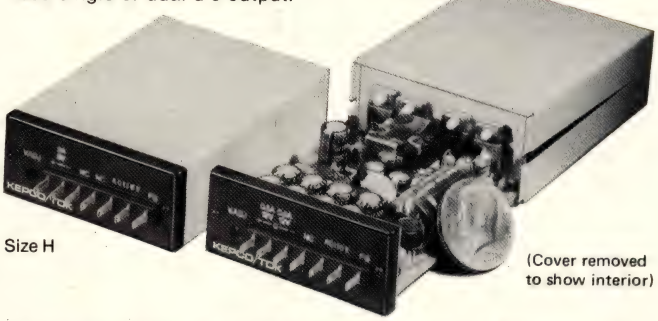
Shock:	20g, 3 axes. 11 ms. ±5 ms. pulse duration.
Vibration:	5–10 Hz, 10 mm amplitude, 3 axes. 10–55 Hz, 2g, 3 axes.

MOUNTING: Tapped 8-32 mounting holes allow these power supplies to be fastened to any of the four major surfaces. The RMD models can be mounted in RA–39 or RA–40 Rack Adapter Systems.

FINISH: Phosphate-treated aluminum.

single utput MP miniature SWITCHING POWER SUPPLIES CMP dual output

The Kepco/TDK Series MP/CMP provide the instrument designer with an extra compact, high efficiency source of stabilized single or dual d-c output.


Size H

(Cover removed to show interior)

Model	Volts	Amperes*	Current Limit	Max. Power
MP 05–H	4.5- 5.5 V	2.0	2.1	10.0 W
MP 09–H	8.0-10.0 V	1.1	1.2	9.9 W
MP 12–H	10.5-13.5 V	1.0	1.1	12.0 W
MP 15–H	13.5-16.5 V	0.8	0.9	12.0 W

Model	Output #1		Output #2		Current Limit	Max. Power
	Volts	Amperes*	Volts	Amperes*		
CMP 01–H	+12 V	0.5 A	−12 V	0.5 A	0.51 A	12.0 W
CMP 02–H	+15 V	0.4 A	−15 V	0.4 A	0.41 A	12.0 W
CMP 03–H	+12 V	0.5 A	− 5 V	0.5 A	0.51 A	8.5 W
CMP 04–H	+15 V	0.4 A	− 5 V	0.5 A	0.41 A	8.5 W
CMP 05–H	+12 V	0.5 A	− 9 V	0.5 A	0.51 A	10.5 W

At +50°C.

NPUT CHARACTERISTICS

-c INPUT: 115 V a-c ±15 V (100-130 V a-c), 47-440 Hz.

PUT CURRENT: Typical: 0.22 A
Maximum: 0.30 A

FFICIENCY: Typical: MP–73%, CMP–75%

ITHSTAND VOLTAGE: 15 KV a-c for 1 minute, input to chassis r input to output.

OLATION Between output terminals and case: 500 V d-c, 100 egohms minimum

OLDING TIME (rated input and output at +25°C): 7.5 milli- econds minimum

OUTPUT CHARACTERISTICS

OLTAGE ADJUSTMENT RANGE: Output voltage is adjustable hrough a range of −10% to +10% of the nominal setting. (See abulated voltage.)

URRENT LIMIT: Rectangular type, fixed. See tabulations.

ECOVERY CHARACTERISTICS: A step load change from 50% to 100% produces less than 4% output excursion. Recovery occurs to within 0.5% of the original setting within 1 millisecond.

AMBIENT OPERATING TEMPERATURE: 0 to +50°C

STORAGE TEMPERATURE: −20°C to +75°C

HUMIDITY: 85% RH, non-condensing

SERIES/PARALLEL: MP/CMP Power Supplies employ a rectagular current limit (not a foldback or re-entrant type). There is, therefore, no lockout problem or start-up problem when two or more units are connected in series or in parallel.

SHOCK and VIBRATION:

Shock:	20g, 3 axes. 11 ms. ±5 ms. pulse duration.
Vibration:	5–10 Hz, 10 mm amplitude, 3 axes. 10–55 Hz, 2g, 3 axes.

MOUNTING: 8-32 tapped holes allow MP/CMP models to be fastened to any of their four major surfaces.

The MP/CMP models can be rack mounted using either the RA–39 or RA–40 rack adapter systems.

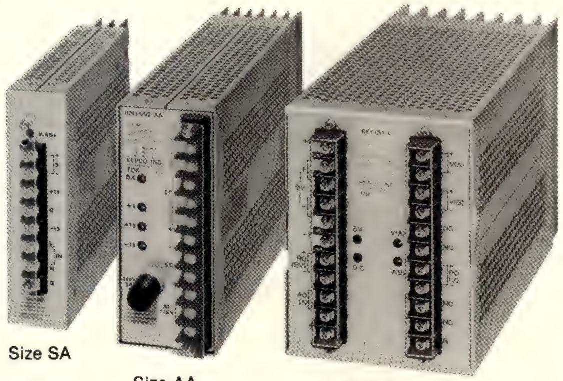
FINISH: Black panel, gray painted case.

RMT

KEPCO/TDK triple-output switching modules

RXT

The KEPCO/TDK Series RMT/RXT provide the instrument designer with a compact, high efficiency source of the multiple voltages needed to drive modern digital-analog circuits. Each model provides a basic 5V logic output. The SA size is rated at 0-6 Amperes; the AA size provides 0-10 Amperes, and the C size is rated at 0-20 Amperes. These are combined with various auxiliary outputs as tabulated below.



Size SA

Size AA

Size C

Size SA

MODEL	PRINCIPAL OUTPUT #1		AUXILIARY OUTPUT #2		AUXILIARY OUTPUT #3	
	Volts	Amps	Volts	Amps	Volts	Amps
RMT 021-SA	+5	6	+12	0.3	−12	0.3
RMT 022-SA	+5	6	+15	0.3	−15	0.3
RMT 023-SA	+5	6	+12	0.3	− 5	0.3
RMT 024-SA	+5	6	+15	0.3	− 5	0.3
RMT 025-SA	+5	6	+12	0.3	− 9	0.3

50°C ratings. At +71°C, derate principal output to 2.4 A.
Derate each auxiliary output to 0.1 A.
Input is 115V a-c only.

Size AA

MODEL	PRINCIPAL OUTPUT #1		AUXILIARY OUTPUT #2		AUXILIARY OUTPUT #3	
	Volts	Amps	Volts	Amps	Volts	Amps
RMT 001-AA	+5	10	+12	1	−12	1
RMT 002-AA	+5	10	+15	1	−15	1
RMT 003-AA	+5	10	+12	1	− 5	1
RMT 004-AA	+5	10	+15	1	− 5	1
RMT 005-AA	+5	10	+12	1	− 9	1

50°C ratings. At +71°C, derate principal output to 4.0 A.
Derate each auxiliary output to 0.3 A.
For 230 V a-c input, add Suffix "-230" to model number.

Size C

MODEL	PRINCIPAL OUTPUT #1		AUXILIARY OUTPUT #2		AUXILIARY OUTPUT #3	
	Volts	Amps	Volts	Amps	Volts	Amps
RXT 051-C	5	20	12	2.0	12	2.0
RXT 052-C	5	20	15	1.6	15	1.6
RXT 053-C	5	20	12	2.0	5	5.0

50°C ratings. At +71°C, derate principal output to 8.0 A. Derate auxiliary output currents as follows: 2.0 A to 0.8 A; 1.6 A to 0.6 A; 5.0 A to 2.0 A.
Input is selectable 115/230V a-c.

Data subject to change without notice.

INPUT CHARACTERISTICS:

Size	a-c Input	Brown-out***	d-c Input
SA	100–130V,47–440Hz,0.85A Typ.	85V a-c/110V d-c	130–170V
AA	100–130V,47–440Hz, 2.0A Typ.	85V a-c/110V d-c	130–170V
*AA-230	200–260V,47–440Hz, 1.2A Typ.	180V a-c/234V d-c	260–340V
C **or	100–130V,47–440Hz, 3.4A Typ. 200–260V,47–440Hz, 1.7A Typ.	90V a-c/180V a-c (234V d-c)	260–340V

*The Size AA and AA-230 are the same, except for the a-c input.

**Plug selectable.

***Operation is maintained down to the brown-out input levels with minor degradation in performance (slightly higher ripple, larger load effect, reduced holding time).

SOFT START: All models have a surge limiting circuit to limit the turn-on current. In the "AA", "AA-230" and "C" designs, a separate logic level on-off circuit is provided for no-surge operation.

EFFICIENCY: RMT: Greater than 65%; RXT: Greater than 75%.

HOLDING TIME: The RMT/RXT stores sufficient energy in its filters to sustain the d-c output a minimum of 20 milliseconds after source power is lost.

EMI:

Conducted: Filters are built into all models to attenuate the line-conducted electromagnetic interference to levels that are acceptable for most applications. Accessory filters may be used between the power supply and the source power line to further attenuate the conducted EMI.

Radiated: Units meet the requirements of VDE 0875/7.71 (level N).

WITHSTAND VOLTAGE:

115V a-c models:	1.5 KV a-c for 1 minute, input to chassis or input to each output.
230V a-c models:	2.5 KV a-c for 1 minute, input to chassis or input to each output.
115/230V a-c models:	2.5 KV a-c for 1 minute, input to chassis or input to each output.

STABILIZATION

STATIC STABILIZATION	RMT-AA All 3 Outputs RMT-SA Principal Output		RMT-SA Auxiliary Outputs		RXT All 3 Outputs	
	Typ.	Max.	Typ.	Max.	Typ.	Max.
SOURCE EFFECT (min-max):	<0.4%	0.8%	<0.1%	0.2%	<0.4%	0.8%
LOAD EFFECT (10%–100%):	<0.4%	1.0%	<0.1%	0.2%	<0.4%	1.0%
TEMPERATURE EFFECT Coefficient per °C:	<0.02%	0.1%	<0.01%	0.05%	<0.02%	<1.0%
Envelope, 0–50°C:	<0.6%	1.0%	<0.4%	0.6%	<0.4%	0.8%
COMBINED EFFECT For rated changes in source voltage, load current and temperature:	<1.4%	2.8%	<0.6%	1.0%	<1.2%	2.6%
TIME EFFECT (8-hour drift) Constant source voltage, load and temperature:	<0.01%	0.05%	<0.01%	0.05%	<0.02%	0.1%
RIPPLE AND NOISE rms:	7 mV	10 mV	4 mV	7 mV	5 mV	10 mV
Source component:	20 mV	50 mV	2 mV	10 mV	20 mV	50 mV
Switching component:	30 mV	100 mV	2 mV	10 mV	30 mV	100 mV
Spike voltage to 10 MHz:	70 mV	100 mV	70 mV	100 mV	70 mV	100 mV

OUTPUT CHARACTERISTICS

VOLTAGE ADJUSTMENT RANGE:

RMT—All outputs adjustable ±10%

RXT—All outputs adjustable from +10% to −30%

CURRENT LIMIT:

Principal outputs: Current limit is adjustable, and has a rectangular characteristic.

uxiliary outputs:

Size SA, current limit is fixed (110%): re-entrant type.

Sizes AA and C, current limit is fixed (110%): rectangular type.

RECOVERY CHARACTERISTICS: A step load change from 50% o 100% produces less than 2% output excursion (or 0.5V, whichver is greater). Recovery occurs to within 0.5% (or 0.05V, whichver is greater) of the original setting within 5 milliseconds for MT, and 2 milliseconds for RXT.

VERVOLTAGE PROTECTION: All three outputs are protected y independent overvoltage protectors of the squelch-type set to pproximately 120% of the nominal output voltage. *Note:* For size A, only the principal output is protected.

EMOTE ERROR SENSING: Output #1 (Size AA and Size C) has rovision for a 4-wire connection to the load capable of compensating up to 0.25 Volts per wire for size AA, and 0.35V per wire for ize C.

EMOTE CONTROL (Size AA and Size C): The output can be urned on and off by TTL compatible logic level switching. An inernal pull-up resistor programs the power supply on in the bsence of external signals.

GENERAL

MBIENT OPERATING TEMPERATURE: 0 to +71°C

TORAGE TEMPERATURE: –20°C to +75°C

HUMIDITY: 85% RH, non-condensing

SHOCK and VIBRATION:

Shock:	20g, 3 axes. 11 ms. ±5 ms. pulse duration.
Vibration:	5–10 Hz, 10 mm amplitude, 3 axes. 10–55 Hz, 2g, 3 axes.

OUTPUT ISOLATION (Size SA): 20 megohms at 500V d-c, any output to chassis. *Note:* The auxiliary outputs are isolated from the principal output but share a single common terminal to produce the indicated + and – voltages. The principal output has a separate ground return.

OUTPUT ISOLATION (Size AA): 20 megohms at 500V d-c, any output to chassis. *Note:* Outputs are not isolated from each other, but produce the indicated levels and polarities with respect to a single common.

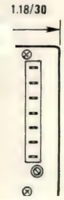
OUTPUT ISOLATION (Size C): 100 megohms at 500V d-c, any output to chassis. *Note:* All outputs are fully isolated and may be grounded for any desired polarity arrangement.

MOUNTING: 8-32 tapped holes allow RMT and RXT to be fastened to any of their four major surfaces.

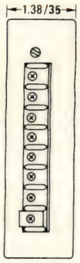
The RMT/RXT models can be rack mounted using either the RA–39 or RA–40 rack adapter systems.

FINISH: Phosphate-treated aluminum.

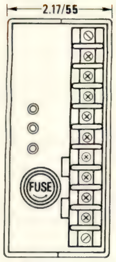
RMD **RMK** **RMT** **RMX** **RXT** **MP** **CMP**



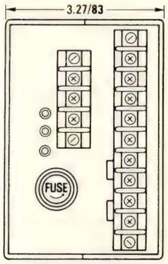
Size "H"



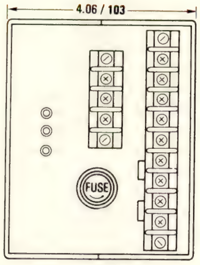
Size "S" and "SA"



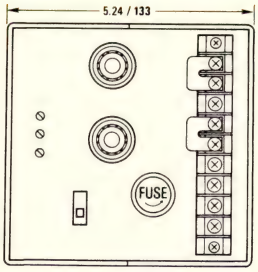
Size "A" and "AA"



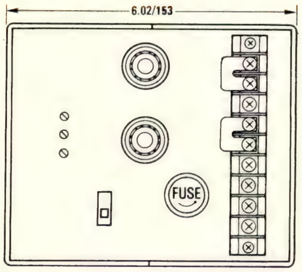
Size "B"



Size "C"



Size "N"



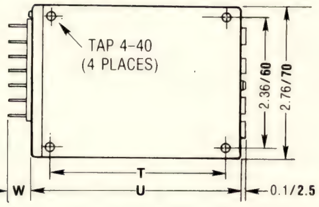
Size "D"

JTLINE DIMENSIONAL DRAWINGS

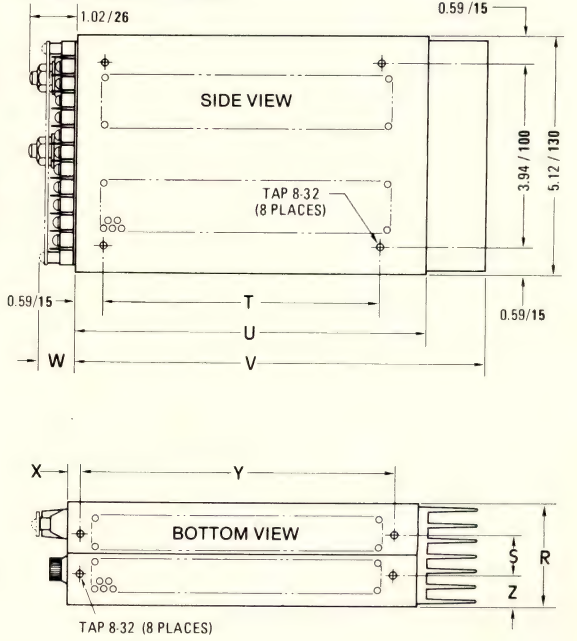
ecimal dimensions in light face type are in inches dimensions in bold face type are in millimeters.

olerance: ±0.016'' **(0.4)** between mounting holes.
±0.032'' **(0.8)** other dimensions.

For Size H models only.



For Size N and D models only.



DIMENSIONS

MODEL	R	S	T	U	V	W	X	Y	Z
ze "H"	1.18 **30**	—	3.15 **80**	3.74 **95**	—	0.44 **11**	—	—	—
ze "S"	1.38 **35**	0.39 **10**	3.86 **98**	5.75 **146**	—	0.63 **16**	0.59 **15**	3.86 **98**	0.49 **12.5**
ize "SA"	1.38 **35**	0.39 **10**	3.86 **98**	5.75 **146**	6.97 **177**	0.63 **16**	0.59 **15**	3.86 **98**	0.49 **12.5**
ize "A"	2.17 **55**	0.87 **22**	5.91 **150**	7.52 **191**	—	0.79 **20**	0.28 **7**	6.69 **170**	0.65 **16.5**
ze "AA"	2.17 **55**	0.87 **22**	5.91 **150**	7.52 **191**	8.82 **224**	0.79 **20**	0.28 **7**	6.69 **170**	0.65 **16.5**
ze "B"	3.27 **83**	1.97 **50**	5.91 **150**	7.52 **191**	8.82 **224**	0.79 **20**	0.28 **7**	6.69 **170**	0.65 **16.5**
ize "C"	4.06 **103**	2.76 **70**	5.91 **150**	7.52 **191**	8.82 **224**	0.79 **20**	0.28 **7**	6.69 **170**	0.65 **16.5**
ze "N"	5.24 **133**	3.74 **95**	5.91 **150**	7.52 **191**	8.82 **224**	0.79 **20**	0.28 **7**	6.69 **170**	0.75 **19**
ze "D"	6.02 **153**	4.52 **115**	5.91 **150**	7.52 **191**	8.82 **224**	0.79 **20**	0.28 **7**	6.69 **170**	0.75 **19**

RA39 system

KEPCO mounting equipment

RA40 system

Different types and sizes of switching power supplies from 10 watts to 300 watts, ac-to-dc and dc-to-dc single output and multi-output, can be accommodated into the RA–39 and RA–40 rack mount systems.

The RA-39 and RA-40 rack mount systems have solid side panels drilled for use with slides (not supplied). The front and rear panels are detachable (not structural). The top and bottom are open to encourage ventilation.

A 2″ space is left between the mounted power modules and the front panel to allow users to mount switches, meters, pilot lights and connectors as desired. A similar space is allowed between the mounted power modules and the rear panel. This allows users to mount barrier strips, line cords, EMI filters, etc. as desired.

THE RA-39 SYSTEM: This system is designed for installation of the following KEPCO/TDK switching power units:

RMK-S; RMK/RMX-A,-B
RMD-SA,-AA,-A,-B
RMT-SA,-AA
MP-H; CMP-H

This system consists of a RA-39 rack adapter and RAB 39-40 rack adapter brackets. These brackets can be installed in different positions into the rack adapter, depending on the size and number of power supplies to be mounted. Use one pair of brackets for each power supply. Two size H models can be mounted on one pair for RAB 39-40 brackets into RA-39 and three size H models can be mounted on one pair of RAB 39-40 brackets into RA-40, using ADP-40H adapter plate (in vertical position).

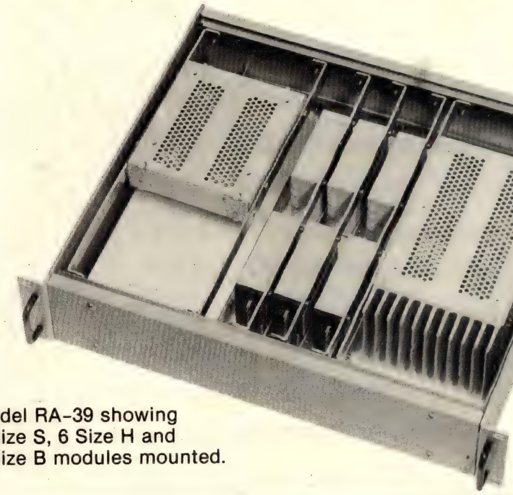
THE RA-40 SYSTEM: This system is similar to RA–39, except that the height is 5 1/4″. This allows the use of the long fins normally supplied with the Power Supplies.

The following KEPCO/TDK switching power units can be installed into RA–40 system:

RMK-S; RMK/RMX-A,-B,-C; RMX-N,-D
RMD-SA,-AA,-A,-B,
RMT-SA,-AA; RXT-C
MP-H; CMP-H

DIMENSIONS

MODEL	DESCRIPTION	H	W	D	SHIP. LBS.	WGT. KG.
RA-39	rack adapter	3 15/22 88.1	19 482.6	14 7/8 377.8	4	1.9
RA-40	rack adapter	5 7/32 132.6	19 482.6	14 7/8 377.8	5	2.3
RAB 39-40	rack adapter bracket	11/16 17.5	3/4 19.1	12 63/64 329.8	1	0.5
ADP-40H	adapter plate for size H	3 9/16 90.5	2 49/64 70.2	1/16 1.6	1	0.5



Model RA–39 showing
1 Size S, 6 Size H and
1 Size B modules mounted.

EMI filters

CONDUCTED EMI SUPPRESSION FILTERS: Kepco Inc. offers a group of seven custom-designed EMI filters for the a-c to d-c and d-c to d-c switch-mode power supplies.

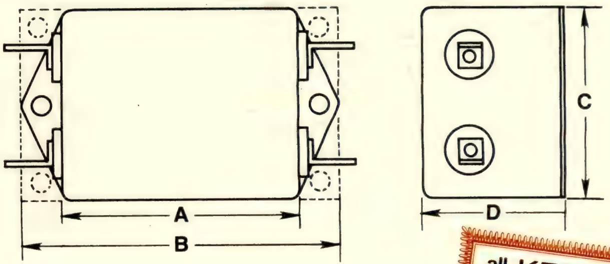
FLA 250–1	115/230V a-c	1 ampere	for RMK/RMX	sizes S & A
FLA 250–4	115/230V a-c	4 amperes	for RMK/RMX	sizes B & C
FLA 250–9	115/230V a-c	9 amperes	for RMX	sizes N & D
FLD 24–5	24V d-c	5 amperes	for RMD	size S, SA & A
FLD 48–3	48V d-c	3 amperes	for RMD	size A
FLD 24–10	24V d-c	10 amperes	for RMD	size B
FLD 48–6	48V d-c	6 amperes	for RMD	size B

The power line filters in series FLA attenuate the conducted noise from a-c to d-c switchers to cause compliance with the category A limit of VDE specification 0871/6.78 (draft revision).

The d-c input filters in series FLD attenuate the conducted noise from d-c to d-c switchers to cause compliance with MIL STD 461A. Notice 3 method CE03.

DIMENSIONS

	A	B	C	D
FLA 250–1	2.50	3.31	2.00	1.50
FLA 250–4	2.88	3.88	2.25	1.50
FLA 250–9	2.88	3.88	2.25	1.50
FLD 24–5	2.88	3.88	2.25	1.88
FLD 48–3	2.50	3.31	2.00	1.50
FLD 24–10	2.88	3.88	2.25	2.00
FLD 48–6	2.88	3.88	2.25	1.88



all KEPCO products are backed by a firm 5-Year Warranty

KEPCO®

Kepco offers a comprehensive line of switching, ferroresonant and linear power supplies in modular and lab / bench formats, write for complete specifications.

131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352 U.S.A. • (212) 461-7000 • TWX # 710-582-2631 • Cable: KEPCOPOWER NEWYORK

BACK AGAIN, BIGGER AND BROADER THAN EVER!

The 1980 Business & Home Computer Shows.

Last year's spectacular success in Boston broadens its reach this year into the prosperous Chicago and Washington/Baltimore markets as well. The Business & Home Computer Shows are coming up again. But space is going fast. So call now if you want to be a part of the hottest thing ever in regional end-user computer expositions.

A SMASH LAST YEAR; EVEN BETTER THIS YEAR.

A record-breaking 31,000 people attended the first of these shows in 1979, a three-day affair in Boston. This year's events are broadened to four days, and will have even bigger promotional budgets than ever. *In fact, the Business & Home Computer Shows have the largest national and regional advertising budget of any computer exhibits except NCC.*

SELLING SHOWS WHERE PEOPLE REALLY BUY.

The Business & Home Computer Shows produce solid results. These are eager audiences – about 70% businessmen and the rest hobbyists – primed with purchasing power in mini- and microcomputers, word processors, peripherals, and software. They come to buy. And cash sales are permitted throughout the show.

CALL NOW! SPACE IS RUNNING LOW.

Four hundred booths and 100,000 square feet of floor space for each of the three shows may sound big, and it is. But over half that space has already been sold, mostly to last year's participants. (Several companies tried single booths last year and are back again with reservations for 12 to 16 booths!) So hurry. Call Bill Mahan or Joan Donahue at (617) 524-4547 to get more facts and assure your reservation.

WASHINGTON/BALTIMORE: D.C. Armory/Starplex, Thu., Sept. 18 thru Sun., Sept. 21.
CHICAGO: McCormick Place, Thu., Oct. 16 thru Sun., Oct. 19.
BOSTON: Hynes Auditorium/Prudential Center, Thu., Nov. 20 thru Sun., Nov. 23.

THE BUSINESS & HOME COMPUTER SHOWS

P.O. Box 678, Brookline, MA 02147

Offer the terminal with more control.

Now you can offer buffered transmission plus business graphics in a simple, smart display terminal.

Regent® 30, the newest terminal from ADDS, offers full upper and lower case display and keyboard, cursor control and editing keys, and transmission capability by character, line or page.

Our patented business graphics let you make bar charts, graphs, histograms–provide a resolution of over 11,500 graphic elements to depict financial or other data.

And with all this extra user control, this new terminal is priced so you can control costs.

Regent 30–another reason why more and more OEMs are specifying ADDS terminals.

For more information write: Displays Division, Applied Digital Data Systems Inc., 100 Marcus Blvd., Hauppauge, N.Y. 11787. Or call (516) 231-5400.

See us at NCC '80, Booth 1562.

ADDS

SOMETHING EXTRA IN EVERYTHING WE DO

TERMINALS

CIRCLE NO. 97

Power supplies rated at up to 1500 W fit into a standard 5 × 8 × 11-in. package and sell for 50¢/W. Improved heat-sinking and power-inverter designs play a part.

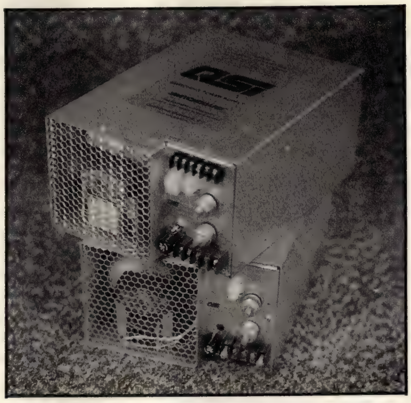
'Super' switcher delivers 3 W/cu in.

The Superswitcher 9000 series from Qualidyne Systems attains power densities above 3 W/cu in. and pricing below 50¢/W (in quantities of 500)—while fitting into a standard 5 × 8 × 11-in., 16-lb package.

The switching supplies reach their power densities of 3.12 W/cu in. for 5-V, and 3.4 W/cu in. for 12-V outputs by combining improved heat sinking and a patented power-inverter circuit with magnetics positioned right in front of an internal ball-bearing fan. The results include up to 1500 W of output at a calculated 50,000 hours MTBF.

With these redesign techniques, the switching transistors operate at a 34-C rise in case temperature above ambient, and the magnetics operate at up to 60 C above ambient.

The heat-sink design incorporates a new way to slot the vanes vertically so that a turbulence is created to break up the laminar air flow, which acts somewhat like an insulator. The resulting improved cooling allows higher-current components to be used, with derating held to that typically found for 750 and 1000-W supplies. What's more, according to the company, this new heat sink allows the unit to run indefinitely under brownout conditions.



The single-output Superswitcher 9000 (bottom) delivers 1500 W, whereas the five-output unit (top) goes up to only 1000 W.

The internal fan, which moves more air than an externally placed unit such as a muffin, has a shaft riding on ball bearings rather than on the more common sleeve bearing. With their reduced grab, ball bearings add another 300 rpm to the fan speed, and create less heat internally than a sleeve-bearing unit.

Another heat and component saver is the company's patented Switchguard power-inverting circuits, which are a modification of the classic "H" or full-bridge inverter. The circuit achieves an essentially resistive switching load-line characteristic, which means that high voltage and high current cannot exist simultaneously on the power transistors. This reduces power dissipation and, hence, the likelihood of secondary breakdown.

Inputs can be specified at 92 to 138 V ac, or 165 to 260 V ac, requiring a single-phase, 47 to 63-Hz hookup. Outputs from 1 to 48 V dc at 250 to 1500 W are available, all adjustable over a range of ±10%. Regulation is within 0.5% for a combined ±20% line change and 0-to-100% static load change. Transient response is 3% peak deviation from nominal for ±25% load step changes, with recovery to within 1% in no more than 300 μs. Output ripple and noise are specified at 1% pk-pk maximum. Minimum power-loss holdup for holdover storage is 30 ms.

Overload protection, which is foldback-type current limiting, is factory-set at 120% of rated output, and features automatic recovery when the overload is removed. Overvoltage protection is factory-set at 125 ±10% of rated output voltage, and requires recycling of the ac input to reset. Overtemperature protection features automatic shutdown and automatic reset. Operating temperature range is 0 to 50 C without derating.

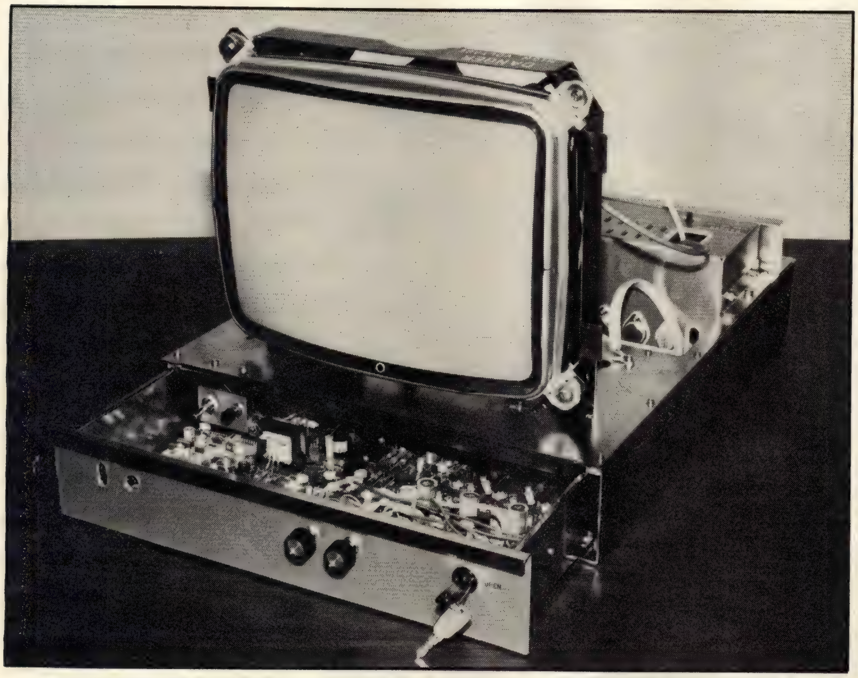
The Superswitcher 900s cost $875 apiece and are available in 8 weeks ARO.

Qualidyne Systems Inc., 2256-5 Main St., Chula Vista, CA 92011. (714) 429-7440.

CIRCLE NO. 301

Ron Shinn, Field Editor

Color monitors provide good resolution, low price



CRT color monitor from Hitachi combines wide bandwidth with medium resolution and low price. Double deflection coils provide convergence correction.

A new color monitor, the HM-1713, from Hitachi America, Ltd. combines low cost with a 0.42-mm dot pitch. The HM-1713 employs a dot-matrix CRT and a unitized in-line gun to achieve 480 horizontal and 480 vertical dot triads on a 13-in. screen.

The new unit does not need complicated convergence circuits and therefore none of the recurring readjustments that these circuits require. Instead, double deflection coils on the CRT monitor provide convergence correction. Misconvergence on the CRT is reportedly less than 0.6 mm, within a circle that has a diameter equal to the vertical height of the display. Outside this circle, the misconvergence is less than 1.2 mm.

The HM-1713 has a 3-dB bandwidth that spans 50 Hz to 25 MHz. Competitive products typically operate with passbands that extend from 50 Hz to no more than 15 MHz.

All these capabilities are also common to the more-expensive high-resolution members of the Hitachi family of color monitors (ELECTRONIC DESIGN, June 18, 1979, p. 146).

Additional features are a pixel rise/fall time of 30 ns, a line frequency of 15 to 18 kHz, and a interlaced refresh rate of 50 to 60 Hz. The monitor also operates in a noninterlaced mode.

Horizontal retrace time is 10 μs and vertical retrace time is 1000 μs. Input to the CRT is an RGB video signal with composite sync on green, using EIA RS-170 as a guide; or, a separate sync signal can be used.

Hitachi America, Ltd., 100 California St., San Francisco, CA 94111. Kazuo (Ken) Takei (415) 981-7871. $1100 (100 qty); stock.

CIRCLE NO. 305

CHROMATICS SALES REPRESENTATIVES:

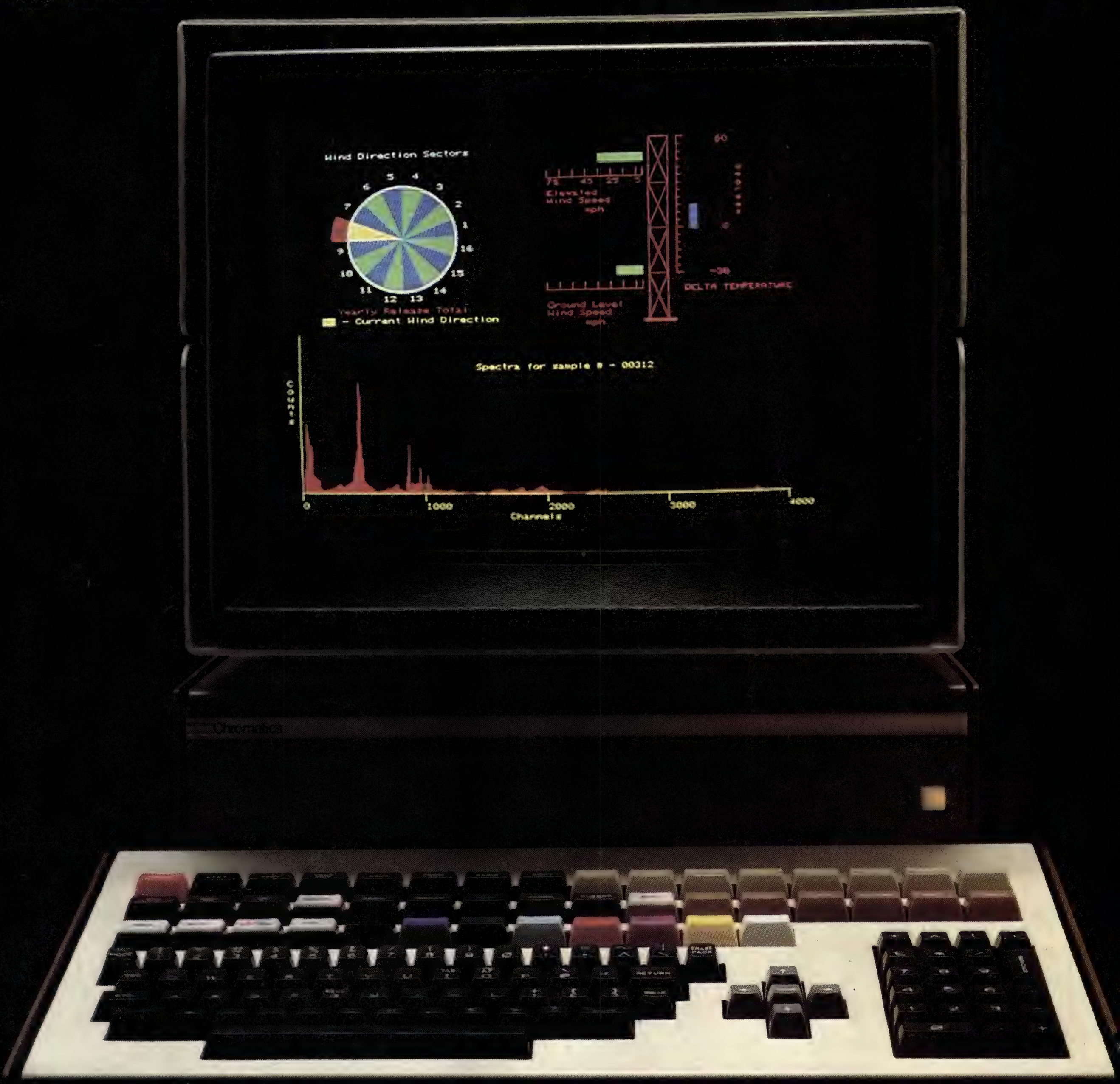
USA. AL: Huntsville Col-Ins-Co. 800/327-6600, **AZ:** Phoenix Thorson Co. 602/998-2444, **CA:** Southern U.S. Graphics Marketing Corp. 213/880-4062, **CA:** Northern Thorson West 415/964-9300, **CO:** Littleton Davis Assoc. 303/795-1400, **CT:** Bartlett Assoc. 914/949-6476, **DE:** Bartlett Assoc. 301/656-3061, **DC:** Bartlett Assoc. 301/656-3061, **FL:** Ft Lauderdale Col-Ins-Co. 800/432-4480, **Fl:** Orlando Col-Ins-Co. Inside Fla 800/432-4480, Local 305/423-7615, **GA:** Atlanta Col-Ins-Co. 800/327-6600, **HI:** U.S. Graphics Marketing Corp. 213/880-4062, **IL:** Northern Dytec/Central, Inc. 312/394-3380, **IL:** Southern Dytec/South 314/731-5400, **IN:** Dytec/Central, Inc. 317/247-1316, **IA:** Eastern Dytec/Central, Inc. 319/683-2282, **IA:** Western Professional Mktg. Services 612/474-5939, **KS:** Dytec/South 314/731-5400, **LA:** Baton Rouge Col-Ins-Co. 800/327-6600, **ME:** Bartlett Assoc. 617/879-7530, **MD:** Bethesda Bartlett Assoc. 301/656-3061, **MA:** Framingham Bartlett Assoc. 617/879-7530, **MI:** Detroit WKM Assoc. 313/588-2300, **MN:** Professional Mktg. Services 612/474-5939, **MO:** Dytec/South 314/731-5400, **NB:** Dytec/South 314/731-5400, **NH:** Bartlett Assoc. 617/879-7530, **NJ:** Bartlett Assoc. 914/949-6476, **NM:** Albuquerque Thorson Co. 505/265-5655, **NY:** Holcomb Bartlett Assoc. 716/657-6309, **NY:** White Plains Bartlett Assoc. 914/949-6476, **NC:** Winston-Salem Col-Ins-Co. 800/327-6600, **OH:** Cleveland WKM Assoc. 216/267-0445, **OH:** Dayton WKM Assoc. 513/434-7500, **OR:** Portland DPM, Inc. 503/258-8203, **PA:** Pittsburgh WKM Assoc. 412/892-2953, **PA:** Wayne Bartlett Assoc. 215/688-7325, **RI:** Bartlett Assoc. 617/879-7530, **SC:** Greenville Col-Ins-Co. 800/327-6600, **TX:** Austin Thorson Co. 512/451-7527, **TX:** Dallas Thorson Co. 214/233-5744, **TX:** Houston Thorson Co. 713/771-3504, **UT:** Davis Assoc. 303/795-1400, **VT:** Bartlett Assoc. 617/879-7530, **VA:** Northern Bartlett Assoc. 804/421-7330, **VA:** Southern Col-Ins-Co. 800/327-6600, **WA:** Seattle DPM Inc. 206/453-9082, **WI:** Eastern Dytec/Central, Inc. 312/394-3380, **FOREIGN COUNTRIES, EUROPE & NEAR EAST:** Techexport, Inc. 617/661-9424, **AUSTRALIA:** Crows Nest NSW TCG 439-6477, **BELGIUM:** Brussels Spesi (02) 37491-12, **CANADA:** 404/447-8797, **FRANCE:** Tech-data 749-40-37, **ISRAEL:** Eldan Electronic Instrument Co., Ltd 533 221/533-242, **SCANDINAVIA:** Sweden Teleinstrument AB 08-380-370, **SOUTH AFRICA:** Pretoria Infodata Pty Ltd 01278-8141, **SWITZERLAND:** W. Stolz AG 057-54655, **UNITED KINGDOM:** Bournemouth Techex Ltd 0202-293-115, **WEST GERMANY:** Techdata GmbH 31025-6

See us at the NCC.

© Chromatics, Inc. 1980

A COLORFUL MESSAGE TO COMPETITION

512 x 512 FOR ONLY $5995



There's no question about it: Our CG 3999 color graphics computer provides high 512 x 512 resolution at the very lowest cost anywhere – just $5995. You not only get 512 x 512 individually addressable and individually color defined dots, you also get the brightest color in the industry, as well as flicker-free 60 Hz non-interlaced images. And for only $895 more, you can add the full keyboard pictured above.

Actually, it's no surprise that this high performance, low pric breakthrough is offered exclusively by Chromatics. After all, we're the world's most colorful computer company. For more information, contact your neares sales rep (listed opposite).

Chromatics™
The World's Most Colorful Computer Company

100 Qty – OEM Price. Keyboard not included.

Chromatics, Inc./3923 Oakcliff Industrial Court/Atlanta, GA 30340/Phone: 404/447-8797/TWX: 810/766-451

CIRCLE [illegible]

THE FACIT 4540 PRINTER REALLY USES ITS HEAD.

The printhead on the Facit 4540 Serial Matrix Printer is so advanced, it practically thinks for itself.

A new concept of printhead design uses 9 stored force flexible hammers to print a 9 x 9 dot matrix pattern bi-directionally at 250 cps.

The printhead movements have been reduced to a minimum. The printing principle assures extraordinarily long printhead life. With no adjustment, no lubrication and ractically no wear. In fact, outstanding harp and consistent printing results are uaranteed for more than a minimum of 00 million characters before any service might be required on the printhead.

The Facit 4540 is a prime example of the integration of mechanics and electronics which has made Facit peripheral data roducts world famous.

Our revolutionary printhead makes Facit 4540 a matrix printer with line printer speed.

Write for more detailed informa how the 4540 Printer can get the mo of your system.

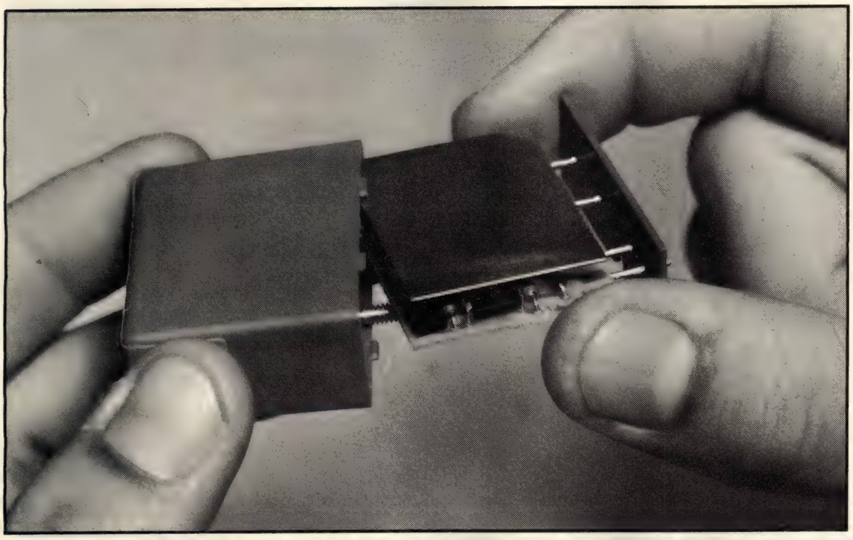
Facit, Inc., 66 Field Point Road,
Greenwich, CT 06830

FACIT
DATA
PRODUCTS

Look for us at ELECTRO '80, Boston and NCC, Anaheim.

CIRCLE NO. 99

Power modules offer TTL-compatibility



Internal buffer amplifiers make power input and output modules like this compatible with low-power MOS and TTL circuitry.

A new series of input and output modules for industrial-control applications offers internal, MOS-compatible buffering, either inverting or noninverting.

The Series 6 Input/Output Modules, from the Crydom Division of International Rectifier Corp., are photo-optically isolated to 3750 V rms (meeting U.S., Canadian, and European isolation requirements) and are TTL-compatible.

The Crydom ac output modules are the 6401, which also comes in MOS-buffered 6411 (inverting) and 6421 (noninverting) versions; and the 6402, which is also available in MOS-buffered 6412 (inverting) and 6422 (noninverting) versions. They can handle output load currents between 0.02 and 3.5 A at 45 C. For the 6401, 6411 and 6421, load voltage is between 12 and 140 V rms; for the 6402, 6412 and 6422, load voltage is between 24 and 280 V rms.

The dc output module, the 6301 is also available in MOS-buffered 6311 (inverting) and the 6321 (noninverting) versions. Each version can handle an output load current of 3.5 A max and a load voltage of 60 V dc min.

The Crydom ac input modules come in two versions: 6201 and 6202. For the 6201, input voltages between 90 and 140 V rms turn the output on, and inputs up to 10 V rms keep it off. For the 6202, these figures are doubled.

The dc input module, the 6101, turns on its output when the input is between 3.0 and 32 V dc; it turns the output off when the input is between −32 and +1.0 V.

Output ratings for all three input modules are the same: 30 V dc, breakdown voltage and 25 mA maximum load current.

All modules plug into a mounting base, so they can be replaced without disturbing field wiring. The small package (1.7 × 1.5 × 0.6 in., including pins) permits up to 24 modules to be mounted in a standard 19-in. rack.

International Rectifier Corp., Crydom Division, 1521 Grand Ave., El Segundo, CA 90245. (213) 322-4987. $7-10 (100 qty.); stock.

CIRCLE NO. 424

Grayhill switch modules

stack this way

or in any array

Customize your circuitry, legends and colors with the versatile "Mix and Match" Grayhill Series 82

Talk about versatility! These unique, long-stroke, wiping contact switch modules are offered in horizontal or vertical legend formats, with 6, 3, 2, and single buttons, so you can strip them or stack them in the exact array you need, while maintaining constant center-to-center button spacing

More versatility! Standard circuitry is SPST thru 4PST—your choice under any button. Or, choose any code up to 7 bits, such as: BCD, BCD complement, octal, hexadecimal, 2 out of 7 or 2 out of 8.

Appearance versatility, too! Choice of legend, button and housing colors—hot stamped, molded-in, or slip-in legends—or any combination thereof.

For detailed information, consult EEM or ask Grayhill for data.

Grayhill INC

561 Hillgrove, LaGrange, IL 60525 (312) 354-1040

CIRCLE NO. 100

Tell it and forget it...

. . . the new CY500 stored program stepper motor controller runs its own program, freeing your host computer for other jobs.

No more one-pulse, one-step operation requiring your host computer to tie itself down to a stepper motor. Now Cybernetic Micro Systems brings you a function-oriented stored program stepper motor controller that allows the user, or host computer, to program it and forget it . . .

The CY500 executes 22 hi-level instructions, either in command mode or as a sequence of internally-stored commands, using single byte code such as 'P' for position, 'R' for rate, and 'S' for slope. Parameter values can be expressed in ASCII-decimal for keyboard programming or binary code from the host computer. Parallel or serial communication.

The stored program capability allows the use of 'DO-WHILE' program looping and 'WAIT-UNTIL' operation. Ten different operational modes allow absolute or relative positioning, full- or half-step operation, hardware or software control of direction, start/stop, . . . and many more.

Numerous input and output control lines allow synchronizing the CY500 with external events or devices and allow each step to be triggered. Stepping at rates up to 3500 steps/sec, the CY500 also provides ramp-up, slew, and ramp-down operation, all under software control. Two interrupt lines request the host's attention if needed.

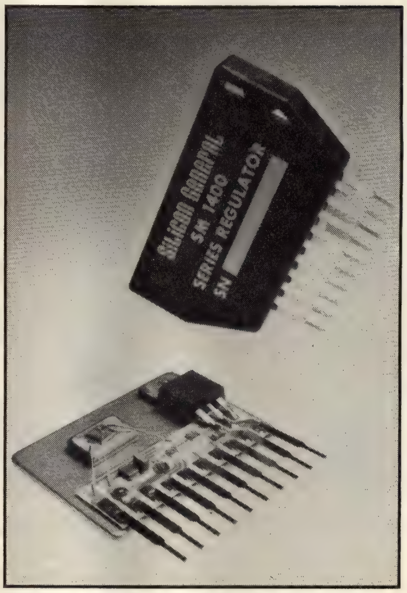
This +5 volt N-MOS TTL-compatible controller is available from stock, today, for only $95.00. Contact Cybernetic Micro Systems. We want to see you program your stepper motor and then . . . forget it.

Cybernetic Micro Systems
445-203 South San Antonio Road
Los Altos, California 94022
(415) 949-0666

(Use your MASTER CHARGE or VISA charge card)

CIRCLE NO. 101

10-A, 150-W regulator —small but protected



Hybrid construction allows this regulator to include both protective circuitry and a voltage reference.

A 10-A, 150-W positive-voltage regulator from Silicon General provides current limiting, current foldback, crowbar overvoltage protection, and a remote-shutdown pin in its compact, pretested package, a 2.32 × 1.26 × 0.37-in. commercial module. In addition, the hybrid circuit contains a precision voltage reference.

Designated the SM-1400, the regulator is the second hybrid offering from Silicon General in this small package. External resistors are used to set parameters of the built-in current limiter and foldback circuits, while the overvoltage trip point and crowbar delay time can be programmed with external capacitors. The output voltage is set from 2 to 37 V by an external RC network.

The module's operating input voltage range runs from 4.5 to 40 V, with a typical no-load input supply current of 8 mA and a maximum of 15 mA. Maximum output current beyond the rated 10 A is 12 A. Line regulation is 0.005%/V, and load regulation is 0.002%/A, both typical. The shutdown input voltage threshold falls between 0.8 and 2 V, while the input shutdown current is 120 μA typical, and 180 μA, maximum.

The reverse-voltage protection diodes have a continuous forward-current rating of 3 A, and a 75-A peak forward-current rating for 5 ms. Baseplate thermal shutdown typically occurs at a temperature of 160 C.

The overvoltage comparator trip points are, rising, between 2.4 and 2.6 V, and, falling, between 2.375 and 2.575 V. Overvoltage-comparator input bias current is −0.3 μA, typical, and −1 μA maximum. The overvoltage-delay-comparator trip threshold lies between 2.5 and 2.7 V, with the delay capacitor charging current between 200 and 300 μA. The continuous SCR crowbar current at the maximum case temperature of 70 C is 20 A, with a peak current for 15 ms of 200 A.

Other typical specifications include 80 dB of 120-Hz ripple rejection, a tolerance of ±1% on the 2.6-V precision voltage reference, and a thermal resistance between the output buffer amplifier's junction and the SM-1400's baseplate of 1.0 C/W. The regulator's remote-shutdown input pin is compatible with TTL voltage levels for easy interfacing with most common logic systems.

In hundreds, the SM-1400 costs $60 apiece. Delivery takes 4 weeks ARO.

Silicon General, 11651 Monarch St., Garden Grove, CA 92641. (714) 892-5531.

CIRCLE NO. 449

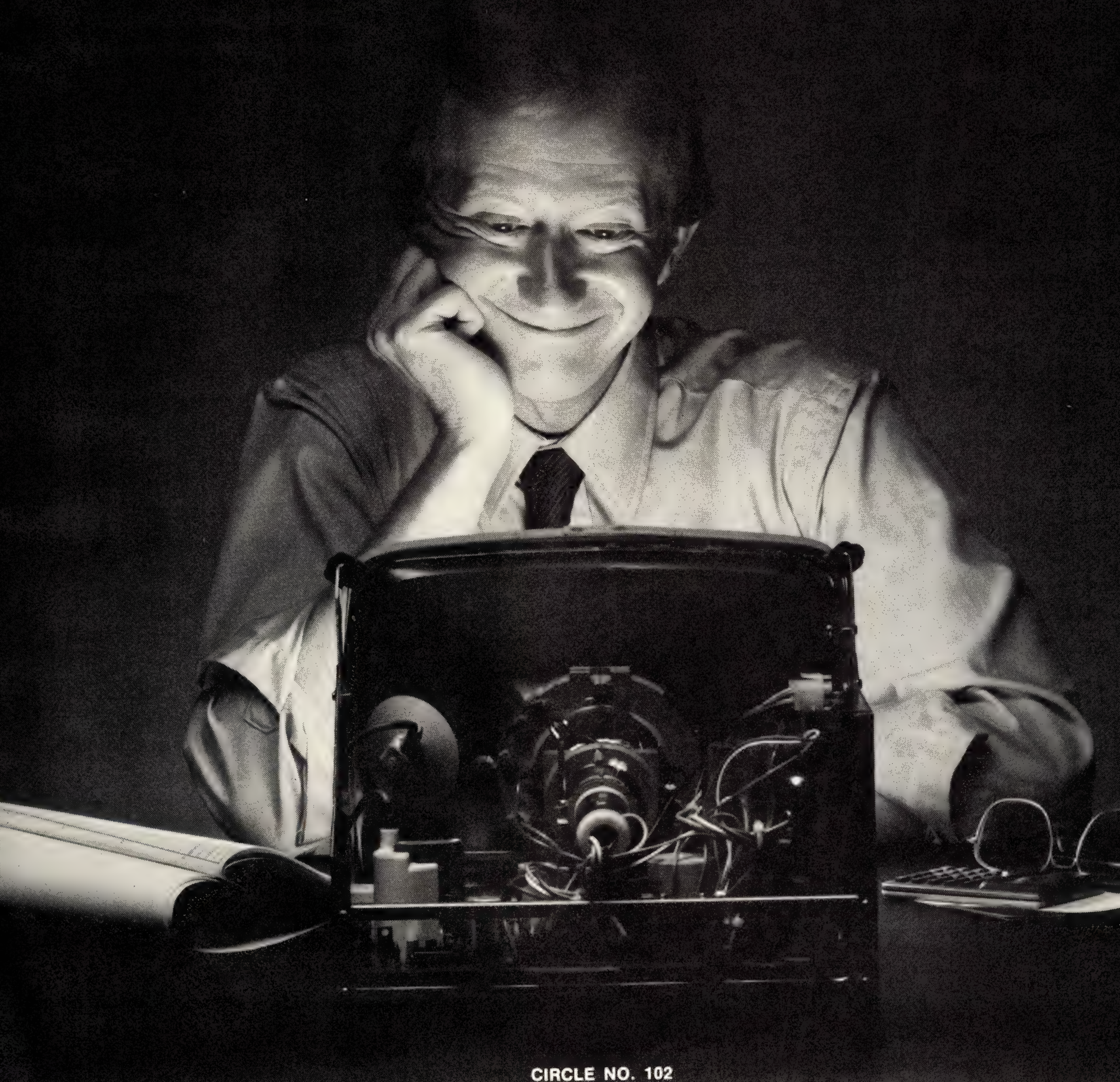
A video bandwidth of 30 MHz and a 1200-line resolution make this new CRT monitor the brightest and sharpest you can get.

C. Itoh's new model 1201BE in our QDM series is capable of receiving separate horizontal drive pulse, vertical drive pulse and video input at the TTL level. This separate signal mode eliminates composite sync and video signal processing. The CRT is equipped with its own power supply unit. P4 phosphor is standard, but optional P31 or P39 phosphors can be provided. Available options: Dynamic Focus, Skip Scan, a non-glare etched face and a 19.5 KHz horizontal frequency.

The high performance and low price offered with this new CRT monitor give you all you need to really outshine your system's competition. Fo complete information contact your nearest C. Itoh representative or C. Itoh Electronics, Inc., 5301 Beethoven Street, Los Angeles, CA 90066; Tel. (213) 390-7778;
Telex: (WU) 65-2451; or 666 Third Avenue, New York, NY 10017; Tel (212) 682-0420; Telex: (WU) 12-5059.

C. ITOH ELECTRONICS, INC.

Introducing the 12" CRT monitor for the systems designer with bright ideas.



CIRCLE NO. 102

Best Source For Microprocessor Quartz Crystals

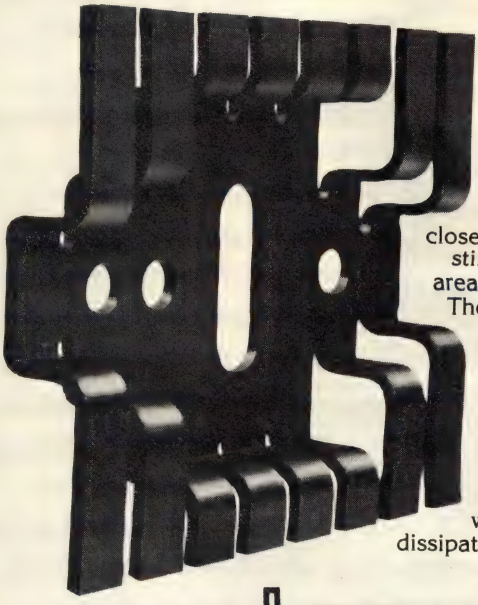
We offer top quality, low price, a wide choice of frequencies and **fast** delivery. Write or phone for complete information including quantity discounts. You can depend on us. **We deliver!**

WES-CON

Wes-Con Products, Inc.
525 University Ave., Suite 705 Palo Alto, CA 94301
Telephone (415) 327-4051 • TELEX 345549

CIRCLE NO. 103

Dissipate more heat on dense PC boards.



Low profile, high dissipation heat sinks from E G & G Wakefield Engineering are ideal for applications where TO-3, TO-66, or TO-220's are mounted on crowded PC boards. The unique shape of these heat sinks permits closer component placement while still providing maximum surface area for excellent heat dissipation. These aluminum alloy heat sinks are available in either plain or black anodized and provide the highest power dissipation per unit cost. Compatible with both metal and plastic cased semiconductors. Currently in-stock and competitively priced. That's why . . . if it has to do with heat dissipation . . . people throughout the electronics industry call us.

EG&G WAKEFIELD ENGINEERING
60 Audubon Road, Wakefield, MA 01880 617/245-5900

CIRCLE NO. 104

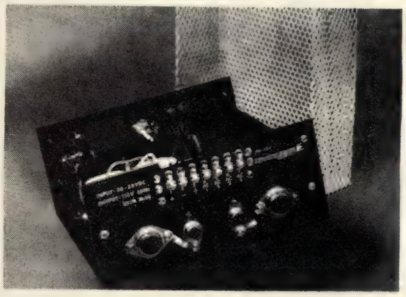
Strong shaft encoder tolerates rough jobs

A heavy-duty shaft encoder, Model 76, withstands tough industrial environments, such as humidity, machine oil, dust and dirt. A large shaft and rugged bearings can take shaft loading of up to 70 lb. Like its standard version, the heavy-duty encoder uses GaAs light sources. Offered in gray code, natural binary or 8421 BCD versions, the encoder comes in a choice of ten resolutions with DTL and TTL compatible outputs. A strong frame is available in two mounting configurations. The encoder is compact, measuring 3 in. by 2.65 in. in diameter.

Litton Systems Encoder, 20745 Nordhoff St., Chatsworth, CA 91311. (213) 341-6161. Stock.

CIRCLE NO. 320

24/28-V dc inverter keeps UPS power going



A 24 or 28-V dc sine inverter, IN-101, supports 115 or 220 V ac equipment in the event of a power failure. Inverter efficiency is 70% with both source and load regulation at ±1%. Outputs are available at 50/60 Hz or 400 Hz. Overload and reverse polarity protection are provided. Distortion is less than 5%. The inverter may be used in any industrial UPS system.

Technipower, P.O. Box 222, Commerce Park, Danbury, CT 06810. (203) 748-7001.

CIRCLE NO. 321

Rectifier bridges carry up to 50 A

B48-2 series rectifier bridges carry single-phase ratings to 35 A and three-phase ratings to 50 A. All circuits are available in voltage classes from 200 to 1200 V. Surge capacity is 400 A. Push-on terminals make installation quick. An insulating barrier separate all connections. Package insulation supports a 2500-V hi-pot test. The parts are UL recognized.

Gentron, 6667 N. Sidney Pl., Milwaukee, WI 53209. (414) 351-1660. Typical $13.15 (100 qty); stock.

CIRCLE NO. 322

Triple-output supplies power data circuits

PC board mountable, triple-output power supplies provide power for data conversion and other circuits where a dual analog supply and a 5-V logic supply are required. TPM 15/200-5/500 provides ±15 V dc and 5 V dc at 200 and 500 mA, respectively. TPM 12/200-5/500 gives ±12 V dc and 5 V dc at 200 and 500 mA, respectively. Input is 115 V ac, ±10% at 60 to 440 Hz. Full output is provided over an ambient range of −25 to +71 C with no derating. Output voltage accuracy is ±1%; output ripple, 2 mV rms maximum; load regulation, 0.05% for 12 and 15-V outputs and 0.1% for the 5-V output.

Datel-Intersil, 11 Cabot Blvd., Mansfield, MA 02048. Sumner Eagerman (617) 339-9341. $83; stock to 4 wks.

CIRCLE NO. 323

CRT supply holds output to 0.005% regulation

An adjustable CRT power supply, Model HV-15AS, maintains 0.005% no-load to full-load regulation over its 3 to 15-kV range. The unit measures 5.4 × 5.2 × 2 in. and is potted in a glass epoxy for maximum environmental protection. Input voltage is 24 V; ripple, 10 V at 500-pF anode capacitance. Model HV-15AS can be supplied with focus and G2 outputs which will track the anode voltage. Current fold-back provides indefinite protection against short-circuit conditions.

National Display Systems, 1 North First St., San Jose, CA 95113. (408) 295-7777. From $150.

CIRCLE NO. 324

for more information,
call TOLL FREE* 800-631-4298

ELECTRONIC MEASUREMENTS INC.

405 Essex Road, Neptune, NJ 07753
The world's largest manufacturer of SCR power supplies
*Except in New Jersey, Alaska, Hawaii and Canada, call (201) 922-9300

CIRCLE NO. 105

Store Recorders have made

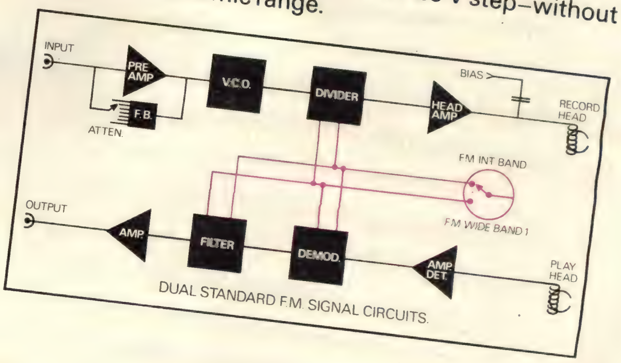
Flick a single switch on a dual standard recorder in the new Racal Store DS range, and you've changed instantly from Intermediate Band to Wideband operation on FM. A single switch that selects either recording standard – without the need to interchange plug-in modules. A single switch changes all the signal channels (four to fourteen) on all seven speeds.

FM Capability

The Store range of instrumentation recorders, well-renowned for research in the scientific, automobile, aerospace and medical fields, now offers an FM capability over the entire band DC to 40 kHz, and up to 300 kHz on Direct Recording.

Greater Flexibility

And even greater flexibility. Switch any channel to unipolar, and the full dynamic range becomes available to either positive or negative going signals. Switch any channel to offset, and you can record a 100 mV peak-to-peak signal on a 20 V step–without losing any dynamic range.



DUAL STANDARD F.M. SIGNAL CIRCUITS.

a quick switch to wideband.

Proven Success

All these outstanding new advantages have been added to the host of features which have made the existing range such a success—like single switch seven-speed selection, full servo operation, dual peak-indicating meters, full remote control of all functions, portability, and operation from AC or battery power sources.

That's why, by switching to the Racal Recorders' new Store DS range, you can make a quick switch to a whole new wideband world.

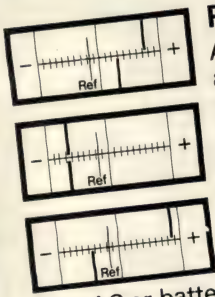
Racal Recorders Limited Hardley Industrial Estate,
Hythe Southampton Hampshire SO4 6ZH England.
Telephone: 0703-843265 Telex: 47600.

Racal Recorders Inc 5 Research Place,
Rockville Maryland 20850,
Telephone: (301) 948 3085.

RACAL

Racal Recorders Always on the right track

CIRCLE NO. 106



BELDEN

FIBER OPTIC CABLE

- "Ruggedized"
- Available Off-The-Shelf
- Plus Technical Assistance from The Cable People

Belden Fiber Optic Cable has high tensile strength. Offers good impact/crush resistant properties. Its "ruggedized" cabling protects against fiber breakage, minimizes microbending losses and keeps heat, cold and moisture from attacking cable performance.

Yet, it's easy to work with! You'll find Belden Fiber Optic Cable has small, workable cable diameters. It's light in weight. Tough. Flexible. Strips easily.

It's available now off-the-shelf. Choose from two core diameters in step—index, plastic clad silica fibers, all silica short distance fiber, or graded index fibers for long distance/high bandwidth applications.

Our Fiber Optics Group is at your disposal. You won't find a better source for technical assistance. If one of our standard products won't fit your application, they can help "customize" a design that will.

CUSTOM TERMINATED CABLE ASSEMBLIES

In addition to supplying standard and "customized" bulk cable designs, Belden can supply cable assemblies cut to length and terminated on one end or both ends with AMP or Amphenol Fiber Optic connectors.

BELDEN

Coming through...

with new ideas for moving electrical energy

FOR "RIGHT NOW" ANSWERS

Call Jack McCarthy at 312-232-8900 or write Belden Corporation, Fiber Optics Group, 2000 S. Batavia Ave., Geneva, Illinois 60134

© 1978 Belden Corporation

H-4-8A

CIRCLE NO. 107

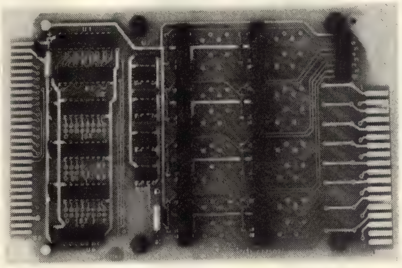
Rack systems combine switcher supplies

Rack-mount systems, RA-39 and RA-40, allow a combination of switching power supply modules in a standard 19-in. equipment housing. Different types and sizes of supplies, from 10 to 300 W, ac-to-dc, dc-to-dc, single and multi-output, can be accommodated in these systems. Modules are bolted in place by adapter brackets. Source power, output and control connections are hardwired to the supplies as needed. The rack adapter systems have solid side panels drilled for use with optional slides. Front and rear panels are detachable. The top and bottom are open to permit ventilation. A 2-in. space is left between the mounted power supplies and the front panel. This allows addition of switches, meters, pilot lights and connectors. A similar space is allowed between the power modules and the rear panel. The front panel and the rack mounting ears are painted light gray, color 26440 per Fed. Std. 595. The rear panel and sides are irridite-treated aluminum.

Kepco, 131-38 Sanford Ave., Flushing, NY 11352. (212) 461-7000. $95; 3 to 4 wks.

Electro: 2139 **CIRCLE NO. 325**

Relay card plugs into STD bus



A relay card, ZT 7502, plugs into a STD bus slot. Three versions are offered: Model ZT 7502/10 has eight SPST dry reed relays; ZT 7502/40 uses eight SPST mercury-wetted reed relays with a 50-VA rating and no contact bounce; ZT 7502/60 includes eight SPDT, mercury-wetted reed relays in a Form C configuration. One of the cards is a second source for the Pro-Log 7502. Each card is tested and burned-in for 168 h to assure reliable operation. All cards feature high voltage breakdown, polycarbonate safety shields for high-voltage protection, user selectable I/O port addresses, PC pads for user-supplied supression networks and a LED display of relay status.

Ziatech, 2410 Broad St., San Luis Obispo, CA 93401. (805) 544-9011. $195 (10); $280 (40); $350 (60); stock.

CIRCLE NO. 326

Our Little Printers Solve Big Problems

If your system requires a reliable printer but you're short on space, our PR series microprinters are the logical choice. Although we occupy a volume of only 2.3″ H x 5.5″ W x 6.0″ D, we are not short on capability. Consider the features:

- 15 or 21 columns
- Full Alphanumeric
- Impact bar matrix print technique
- Two-color snap-in ribbon cartridge
- Plain paper
- Multiple copies
- Rugged construction
- Microprocessor compatible
- Optional DC operation

One thing we *are* short on, however----*price.*

Sodeco manufactures tape and ticket printers, microprocessor-based printer controllers, and printer accessories to suit a variety of applications for the OEM.

For more information on how our little printer can solve your problems call
(914) 592-4400 or
write Sodeco, Div. of
Landis & Gyr, Inc.,
4 Westchester Plaza,
Elmsford, N.Y. 10523.

SODECO

LANDIS & GYR

CIRCLE NO. 108

PC-mount supplies give triple outputs

PC board-mountable, encapsulated modules supply the power needs of logic and analog circuits. TPM 15/150-5/1000 provides ±15 V dc at 150 mA and 5 V dc at 1000 mA. TPM 12/150-5/1000 puts out ±12 V dc and 5 V dc at the same output currents. The modules measure only 3.5 × 2.5 × 1.56 in. Full rated output is provided over an ambient temperature range of −25 to +85 C. The series includes output current-limiting protection, 0.05% line regulation for the 5-V output and 0.02% for the 15 or 12-V outputs with an impedance of 0.1 Ω for analog outputs and 0.05 Ω for logic outputs. Output voltage accuracy is ±1%; output ripple, 2 mV rms maximum; load regulation, 0.05% for the 12 and 15-V outputs and 0.1% for the 5-V output. Tempco is 0.02%/°C while transient recovery time is 50 μs maximum.

Datel-Intersil, 11 Cabot Blvd., Mansfield, MA 02048. Sumner Eagerman (617) 339-9341. $93.50; stock to 4 wks. **CIRCLE NO. 435**

From Frame to CRT . . .

we've built Linear and Constant Voltage Transformers - U.L. amd C.S.A. Listed - and for use in equipment conforming to these international specs: IEC-380; IEC-435; VDE-0730; VDE-0804

What can we do for you?

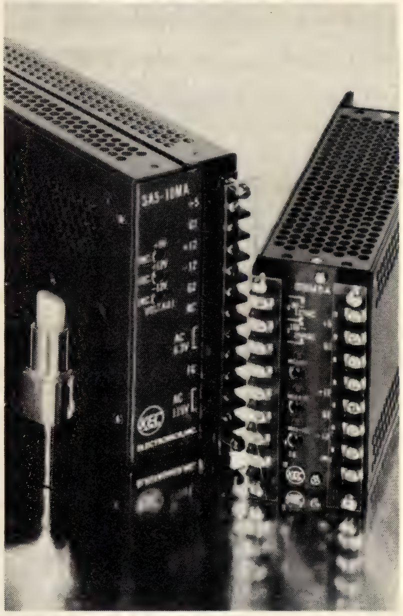
Just give us a call
618-654-2341
Nationwide Reps

Basler Electric
Highland, Illinois

BOX 269 HIGHLAND, ILLINOIS 62249 TWX 910-996-2522

CIRCLE NO. 109

Multi-output switchers offer 40 and 80 W



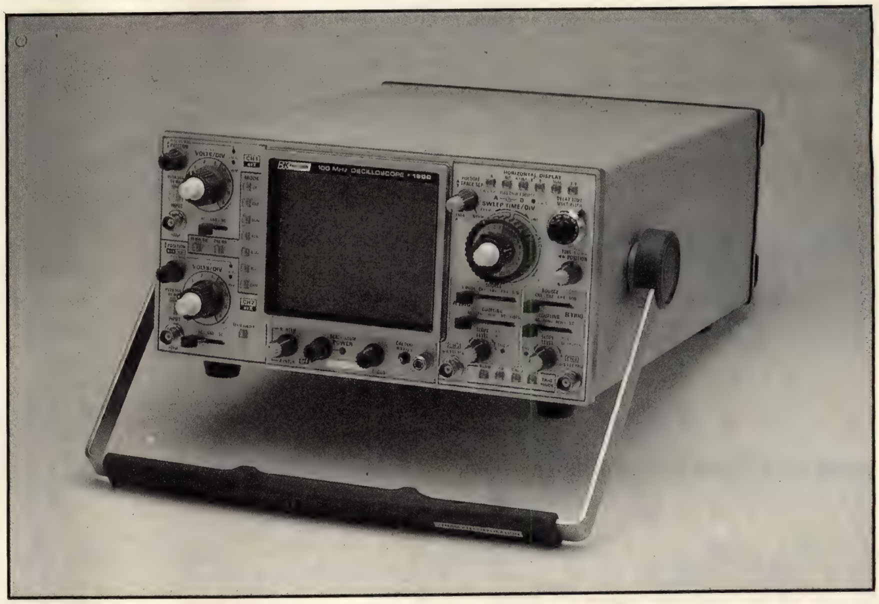
SAM and SBM Series switching power supplies offer three output voltages, each individually adjustable. The compact, modular units provide 80 W (SAM) and 40 W (SBM) with tight regulation and low EMI. The SAM series gives 5 V at 10 A and any two additional combinations of ±12, ±15, 9 or −5 V at 1 A. Line regulation is 0.3%; load regulation, 0.8% from no load to full load. The SBM series is available with outputs of 5 V at 5 A and any two combinations of ±12, ±15, 9 or −5 V at 0.5 A.

KEC Electronics, 19300 S. Vermont St., Gardena, CA 90248. (213) 515-2561. $329 (SAM); $260 (SBM) (100 qty); 4 to 6 wks.

CIRCLE NO. 436

A highly efficient oscilloscope with a switching power supply provides a choice of high-impedance and 50-Ω inputs.

16-lb 100-MHz scope displays four traces


The touch-sensitive controls on the front panel of this lightweight 100-MHz scope are illuminated from behind by red LEDs when the controls are activated.

A four-channel portable that weighs just 16 lb aims squarely at the large market for 100-MHz portable oscilloscopes, which is currently dominated by the Tektronix 465B. The Model 1500 from B&K Precision possesses a full complement of controls for two of its channels and limited control (a two-position attenuator and limited position control) for the remaining two.

Among other applications, the two extra channels can be used to provide a trigger-view facility for the main channels and to give simultaneous views of the signals at four points in a clocked digital circuit.

Four signals that are unrelated in frequency cannot be displayed in the four-trace mode, because the trigger for the four channels must come from either channel 1 or channel 2. However, when the scope is used as a standard dual-trace instrument, alternate triggering is available for channels 1 and 2, and the applied signals can therefore be unrelated in frequency.

The 1500 provides both standard high-impedance (1 MΩ, shunted by 20 pF) and 50-Ω inputs on channels 1 and 2. The 50-Ω inputs prove their value in high-frequency applications, where the 20-pF shunt capacitance of the high-impedance ports can cause serious measurement errors.

Touch-sensitive panel switches control all of the new scope's function switching. When activated, the switches are illuminated from behind by red LEDs.

The scope owes its light weight—as well as high efficiency and protection against brownouts—to its switching power supply. Approximately 50 W suffices to power the scope, which can run on line voltages from 90 to 132 V (or 180 to 264 V).

In addition to the standard voltage-vs-time display, the Model 1500 can plot channel 1 against channel 2. In this mode, the horizontal amplifier has a 3-dB bandwidth of 4 MHz.

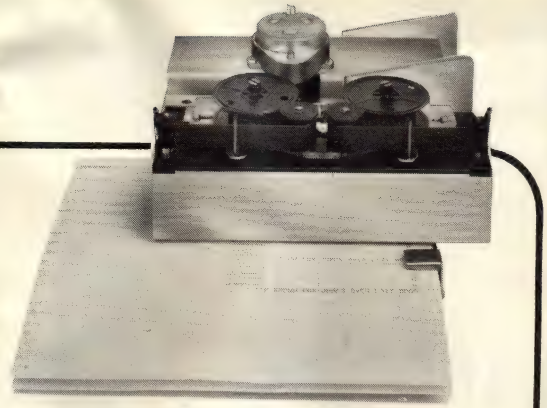
The sensitivity of the 1500 is 5 mV/div up to 100 MHz (1 mV/div up to 30 MHz when the ×5 gain control is activated) for channels 1 and 2. A ten-position attenuator extends sensitivity to 5 V/div in a 1-2-5 sequence. Sensitivity on channels 3 and 4 is user-selectable, as either 100 mV/div or 1 V/div.

The scope sells for $2575 and will be stocked by selected distributors starting in September.

B&K-Precision, 6460 W. Cortland St., Chicago, IL 60635. (312) 889-9087.

CIRCLE NO. 425

Mike Riezenman, Managing Editor



Open For Business

Bring on your forms, any forms. Whether you need to print on bank checks or multipart reports, standard pages or outsize sheets, our alphanumeric DMTP-8 impact form printer has a 50 character/line capacity, edge guide sensor and three open sides to take your work flow as it comes. Everything fits. And with the exceptionally long needle stroke, every message is crisp and clear — even on multiple copies from .003" to .015" thick.

Work it hard. Work it long, even at high-volume POS jobs. With its heavy-duty construction and extra-long life dot matrix print head, the DMTP-8 is made to take it. Other advantages: programmable character pitch, and the long-haul economy of replaceable ink rollers and a self-reversing ribbon with a 10-million character life. And, of course, the price: just $269 in 100's. Write or call now for details.

P A
PRACTICAL AUTOMATION, INC.
Trap Falls Road, Shelton, Conn. 06484/Tel: (203) 929-5381

CIRCLE NO. 110

ROYTRON™
plug-compatible reader/punch

Desktop combination reader/punch with serial asynchronous RS-232C compatible interface. Designed to operate with a terminal device on the same serial data lines or alone on a dedicated serial line. Reader will generate data at all standard baud rates up to 2400 baud.

Punch accepts data at all standard baud rates up to 600 baud continuous or 4800 baud batch, utilizing a 32 character buffer.

Two modes of operation are provided: *Auto Mode* — Simulates Model ASR 33 Teletype using ASCII defined data codes (DC 1, 2, 3 and 4) to activate/deactivate the reader or punch; *Manual Mode* — Code transparent mode. Panel switches control activation/deactivation of reader or punch and associated terminal device.

Tape duplication feature is provided by setting unit to LOCAL mode.

MODEL 1560-AS

High-speed, compact, with self-contained electronics and power supply. Complete in attractive noise dampening housing.

For full details, write or call us.
Litton
WESTREX OEM PRODUCTS
1140 Bloomfield Avenue, West Caldwell, N.J. 07006 (201) 227-7290
IN U.K. — WESTREX OEM PRODUCTS, Airport House, Purley Way, Croyden, Surrey, England
IN FRANCE — WESTREX OEM PRODUCTS, 103-107 Rue de Tocqueville, 75017, Paris, France

CIRCLE NO. 111

Logic probe traces digital signals

A digital logic probe, Model MLB-1, measures logic states and levels, both statically and dynamically, and detects spurious random pulses. A switch selects the logic type being tested; TTL, DTL or CMOS. A pulse mode aids dynamic testing while a memory function catches nonrepetitive fast pulses. Logic states are indicated by LEDs. Pulse trains and rectangular waveforms to 10 MHz can be checked. Minimum pulse width is 50 ns. Model MLB-1 is powered by circuit under test. An external supply can be used.

Non Linear Systems, P.O. Box N, Del Mar, CA 92014. (714) 755-1134. $41.95.

CIRCLE NO. 317

4 -1/2 digit DPM narrows resolution to 10 μV

A series of 4-1/2 digit digital panel meters (DPMs), Series 2840, offer 0.02% accuracy where 10-μV resolution is needed. The red LED readout shows a 19999 count. Polarity and zeroing are automatic. Versions are available in eight stock dc voltage and current ranges and come with such options as display hold, programmable decimal point, BCD output and custom ranges. Model 2840 operates from 120, 220 or 240 V ac, 50 to 400 Hz. Model 2841 is for 5-V dc operation. Both types fit standard 1.682 × 3.622-in cutouts.

Simpson Electric, 853 Dundee Ave., Elgin, IL 60120. (312) 697-2260. $175.05.

CIRCLE NO. 327

Video processor reduces host computer's load

A microprocessor-based unit, the Video Processor, supports up to eight self-scanned diode arrays, diode array cameras or vidicon cameras for use in optical inspection, non-contact process monitoring, optical gauging and optical character recognition. The processor acts as an intelligent front end, reducing the load on a host computer and simplifying the task of interfacing the arrays or cameras to the computer. Both Parallel and RS-232 interfaces are available from stock while RS-423 and IEEE-488 interfaces are available on special order. The processor can also serve as a tool for the evaluation of array performance and the testing of prototype systems.

Integrated Photomatrix, 1101 Bristol Rd., Mountainside, NJ 07092. (800) 526-7558.

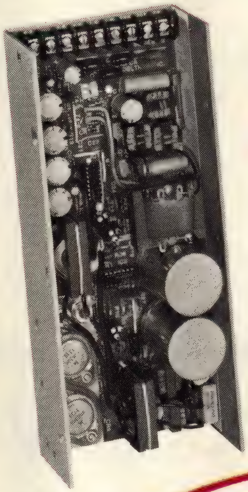
CIRCLE NO. 328

Thermal head improves recorder accuracy

A fixed, linear-array thermal head adds improved accuracy and annotation to the TA 600 analog graphic recorder. No pens, ink or pen-motor linkages can interfere with reliability or create overshoot or hysteresis problems. In addition, the recorder uses plain, low-cost thermal paper since grids are selected and printed along with the traces. The TA 600 handles up to 32 overlapping channels of analog signals on a 6-in. chart. The basic mainframe has space for four dual-channel signal conditioners, including dc preamplifiers, dc bridges and thermocouple preamplifiers. Full annotation of chart speed, preamp type, range, channel number, filtering or suppression is possible for each analog signal. The use of an optional microprocessor gives the recorder added versatility, such as remote control of functions. Maximum system error is ±0.2% of full scale while nonlinearity is also ±0.2% of full scale. Chart speeds range from 50 mm/s to 1 mm/h. Maximum printing rate is 200 horizontal increments per second.

Gould Instruments Div., 3631 Perkins Ave., Cleveland, OH 44114. (216) 361-3315. $4650.

Electro: 400 **CIRCLE NO. 329**



DELTRON SWITCHERS are NO GLITCHERS

The Quiet Ones

- Current fed drivers
- DM filters
- CM filters
- $\frac{dv}{dt}$ snubbers
- $\frac{di}{dt}$ limiting
- Shielded case
- Spike limiting varistors
- No fans

Get Quiet!

1 TO 4 OUTPUT SWITCH MODE ***POWER SUPPLIES—*** *TO 320 WATTS*

- *Stock*
- *UL 478*
- *All outputs highly regulated*
- *Exclusive Variable Power Partitioning*
- *Low cost*
- *3 year warranty*

COMPLETE POWER SUPPLIERS

- Switcher
- Linear
- Ferro
- SCR

STANDARDS—CUSTOMS

Deltron inc.
Wissahickon Avenue • North Wales, PA 19454
Tel: 215/699-9261 Twx: 510/661-8061

AC34

CIRCLE NO. 112

Voltage reference transfers lab accuracy

A portable voltage reference, 400 Series, provides precision transfer of standard-cell accuracies in laboratory, production and field applications. The solid-state instrument operates on ac power or built-in, rechargeable batteries. Output impedance is low and the voltage output range is 0 to 10.99999 V. Overload protection is built-in. The instrument permits work at standards-lab accuracies, in a variety of locations, without danger of damage to prime standards. An optional resistive divider can be used in conjunction with a nullmeter to determine higher voltages to accuracies of better than 15 ppm in field work.

Rotek Instrument, 220 Grove St., Waltham, MA 02154. (617) 899-4611. **CIRCLE NO. 330**

Frequency synthesizer covers microwave range

A microwave frequency synthesizer, WJ-1292, covers 10 MHz to 18 GHz. Keyboard selected signals can be operator-programmed for sweeps over any portion of its range. Performance options allow customizing of the instrument for such features as leveling and high-power operation. Additional rf source heads give extended coverage to 40 GHz. Units can be added to provide attenuation, modulation and signal switching. Standard computer or IEEE-488 interfaces can be specified.

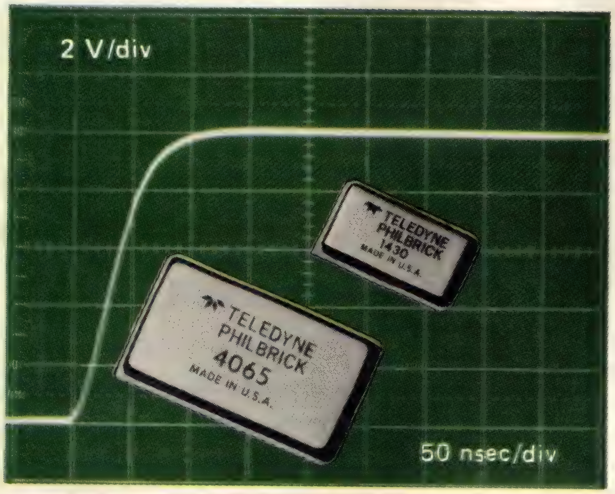
Watkins-Johnson, 3333 Hillview Ave., Palo Alto, CA 94304. (415) 493-4141. **CIRCLE NO. 331**

Laser meter simplifies wavelength testing

A digital-display meter, the Wavemeter, measures the absolute wavelength of any cw laser operating between 0.4 and 4 μm. The readout is updated every 1.6 s to facilitate tuning the laser or monitoring its drift. Model WA-20 monitors wavelength through the entire range with only the addition of an optional IR assembly. Accuracy is ±1 part in 10^6 or a readout limit of 0.001 nm in the visible spectrum or 0.01 cm^{-1} in the IR region. Model WA-10 suits applications required a more restricted range of 0.4 to 1 μm with an approximate accuracy of ±5 parts in 10^6. The meters function with as little as 1 mW of input signal power.

Burleigh Instruments, Burleigh Park, Fishers, NY 14453. (716) 924-9355. **CIRCLE NO. 332**

300 NANOSECOND VOLTAGE DAC


2 V/div
TELEDYNE PHILBRICK 1430 MADE IN U.S.A.
TELEDYNE PHILBRICK 4065 MADE IN U.S.A.
50 nsec/div

True 12-Bit D To A Conversion

. . . is achieved by combining our 4065 current DAC and our 1430 fet operational amplifier. The result is a 12-bit hybrid voltage DAC system with a voltage settling of under 300 nsec to 0.01%. In addition, these units offer operation from −55°C to +125°C and the high reliability that is inherent in MIL-STD-883 screening.

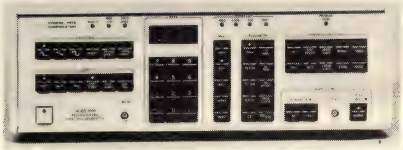
For more information or special OEM pricing, contact Ted Serafin, Product Marketing Manager.

TELEDYNE PHILBRICK

DATA CONVERTERS, V/F/V CONVERTERS, LINEARS, NONLINEARS, POWER SUPPLIES
Allied Drive at Route 128, Dedham, Massachusetts 02026
Tel: (617) 329-1600 TWX: (710) 348-6726 Telex: 92-4439

CIRCLE NO. 113

Smart function generator learns testing steps



An intelligent, programmable function generator, Model 5900, learns entire testing procedures and can repeat these steps at any given rate. The instrument's autoprogrammer stores approximately 200 steps, eliminating need for a controller in low-level systems and reducing demands on CPU time in larger systems. Auto-programming, combined with arithmetic and auto increment and decrement functions, provides precise linear sweeps over a 10,000:1 range, log sweeps over the entire instrument range and nested loops. The loops can intermix log and linear sweeps and also operate on frequency, period, pulsewidth, duty cycle, amplitude (peak or rms), dc offset, burst cycle count or any combination. Instrument range is 100 μHz to 5 MHz. Model 5900 produces sine, square, triangle, pulse and sawtooth waveforms.

Krohn-Hite, Avon Industrial Park, 255 Bodwell St., Avon, MA 02322. (617) 580-1660. $3000; 13 wks.

CIRCLE NO. 333

LRC bridge displays results on CRT

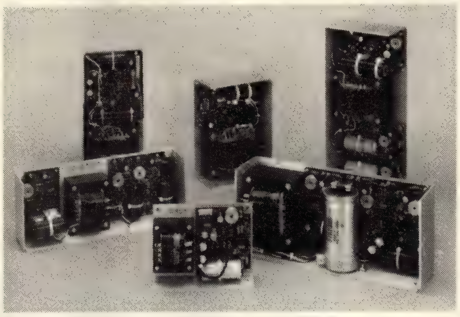
Operating under the control of a microprocessor, Model 2100, an LRC bridge, measures 11 impedance characteristics and displays results on its built-in CRT. Series or parallel impedance can be measured at over 3000 discrete frequencies from 20 Hz to 20 kHz. Test voltages are selectable up to 1 V rms while test currents can be varied up to 75 mA. Depending on measurement mode, the instrument provides an accuracy ranging from 0.1 to 0.02%. The front panel contains a 32-key interactive keyboard and a 5-in. CRT. A complete system status display includes test level, test frequency, series or parallel mode, programmable settling and integration times and selectable averaging. For production use, the Model 2100 can be programmed to display pass-fail or sorting information. Field-installable options include RS-232 and IEEE-488 interfaces and nonvolatile memory. Software packages are expected this fall.

Electro Scientific Industries, 13900 N.W. Science Park Dr., Portland, OR 97229. (503) 641-4141. Approx. $4000.

CIRCLE NO. 334

Disk Memory Power Supplies

NUMBER 1 IN D.C. POWER SUPPLIES



Power-One, a leading supplier to the Disk Drive Industry, now offers a complete line of power supplies for FLOPPY DISK and new WINCHESTER FIXED DISK applications.

Call or Write for our New Catalog.

WINCHESTER FIXED DISK

SHUGART - CENTURY - MICROPOLIS are just a few drives powered by this new universal model. Powers (1) Winchester drive plus controller circuitry.

1st Output	2nd Output	3rd Output	Model	Price (1 - 9)
+ 5V @ 9A	– 5V or – 12V @ .8A	+ 24V @ .7A/4.5A PK	CP384	$120.00

FLOPPY DISK - 5¼" MEDIA

BASF - SHUGART - PERTEC - SIEMENS plus all other popular 5¼" media drives.

1st Output	2nd Output	Model	Price (1 - 9)
+ 5V @ .5A/.7A PK	+ 12V @ .9A/1.8A PK	CP340	$ 44.95
+ 5V @ 2A	+ 12V @ 4A	CP323	$ 74.95

CP323 powers up to (4) drives simultaneously.

FLOPPY DISK - 8" MEDIA

SHUGART - PERSCI - CDC - WANGCO plus many other single and multiple drive applications.

1st Output	2nd Output	3rd Output	Model	Price (1-9)
+ 5V @ 1A	– 5V @ .5A	+ 24V @ 1.5A/1.7A PK	CP205	$ 69.95
+ 5V @ 2.5A	– 5V @ .5A	+ 24V @ 3A/3.4A PK	CP206	$ 91.95
+ 5V @ 3A	– 5V @ .6A	+ 24V @ 5A/6A PK	CP162	$120.00
+ 5V @ 1.7A/2.2A PK	– 5V @ .15A/.2A PK	+ 24V @ .2A/3A PK	CP272A	$ 91.95
+ 5V @ 2A	+ 12V @ .4A	– 12V @ .4A	HTAA-16W	$ 49.95

CP272A powers Persci Drives (includes unregulated 7 - 10V @ 1.2A/10A PK).
HTAA-16W powers Persci controller.

power-one D.C. POWER SUPPLIES

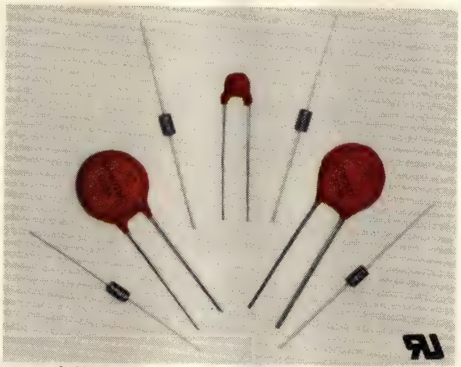
Power One Drive • Camarillo, CA 93010 • (805) 484-2806 • TWX 910-336-1297
Eastern Regional Headquarters • (518) 399-9200

CIRCLE NO. 114

VECO

METAL OXIDE VARISTORS from VECO Lower System Costs

Victory's new metal oxide varistors are designed to lower system costs and increase product safety through improved circuit and system reliability. It is very important to note that the published energy rating expressed in joules is after the application of 2000 pulses, where as many competitive devices are rated at only one pulse.



Veco metal oxide varistors exhibit improved response times, increased current capability, low standby power consumption and superior clamping characteristics in a compact, lightweight package that's UL recognized for "across-the-line" components.

VECO
VICTORY ENGINEERING CORP.
Victory Road, P.O. Box 559, Springfield, NJ 07081
(201) 379-5900 TWX: 710-983-4430

CIRCLE NO. 115

Adaptive Science puts a lot of microphistication
in your hand. Like these three new one-card computers.
Get a 6802 or a 6809 microprocessor, RAM, EPROM,
PIAs, ACIA and triple timers — all on one card.
Ask for ModulasOne #550, 560 or 590. They're available now.
Call (415) 652-1805 for immediate delivery.

ModulasOne-Card Computers
Adaptive Science Corporation, 4700 San Pablo Avenue, Emeryville, CA 94608

CIRCLE NO. 116

Drop-proof VOM resists severe impacts

A ruggedized and sealed VOM, Model WV-590, endures dropping, banging and shaking without damage. In addition to protection against physical damage, the meter also tolerates electrical abuse. A varistor protects the movement from overload while a snap-in fuse guards the electrical circuits. The instrument measures dc and ac voltage, dc current, resistance, dB and audio-frequency voltage levels—a total of five functions with 20 ranges. The unit is housed in an ABS plastic case and uses a ring-core, taut-band meter movement.

VIZ Manufacturing, 335 E. Price St., Philadelphia, PA 19144. (215) 844-2626. $69.

CIRCLE NO. 335

Microwave power meter spans 200 kHz to 18 GHz

A microwave power meter, Model 4200, covers a 200 kHz to 18-GHz range, depending on the power sensor used. Operating under the direction of a microprocessor, the instrument stores data for up to four, interchangeable power sensors in its nonvolatile memory. This includes sensitivity and linearization requirements, as well as up to nine frequency calibration factors for each sensor. Measurements can be made using either a 3-1/2 digit power display or a 4-digit dB display with a resolution of 0.01 dB. An uncalibrated analog meter indicates power levels for peaking and nulling operations. The dB display can be either in terms of dBm (1 mW into 50 Ω) or relative dBr. A second channel option allows simultaneous use of two power sensors. Zeroing is automatic and autoranging is standard. High and low dB limits can be entered, with a front-panel annunciator and rear-panel TTK output to signal an out-of-limits condition. Options include a field-installable IEEE-488 bus interface and a rechargeable battery supply. Power range is 1 nW to 100 mW (−60 to +20 dBm), depending on the diode sensor.

Boonton Electronics, Rt. 287 at Smith Rd., Parsippany, NJ 07054. (201) 887-5110. $1800; 8 wks.

CIRCLE NO. 336

Absorption mW meter covers VLF to 1 GHz

An rf milliwattmeter, Model 6257, terminates and measures the output of low-power signal sources directly, without the need for charts. A front-panel range-switch selects one of three ranges from 0 to 3 W over a 100 kHz to 1-GHz range. The unit is designed to measure the output of broadband oscillators, signal generators, hand-held transceivers and any other low-power device. Used in conjunction with Tenuline attenuators, the milliwattmeter's maximum full-scale range can be expanded to 25 or 100 W. The unit's diode detector also serves a demodulator of AM transmission envelopes. The audio output is available at a front-panel, miniature phone jack for feeds into a high-impedance display or analysis instrumentation. VSWR is less than 1.1 to 512 MHz and less than 1.15 up to 1 GHz in 50-Ω coaxial systems.

Bird Electronic, 30303 Aurora Rd., Cleveland (Solon), OH 44139. (216) 248-1200. $265.

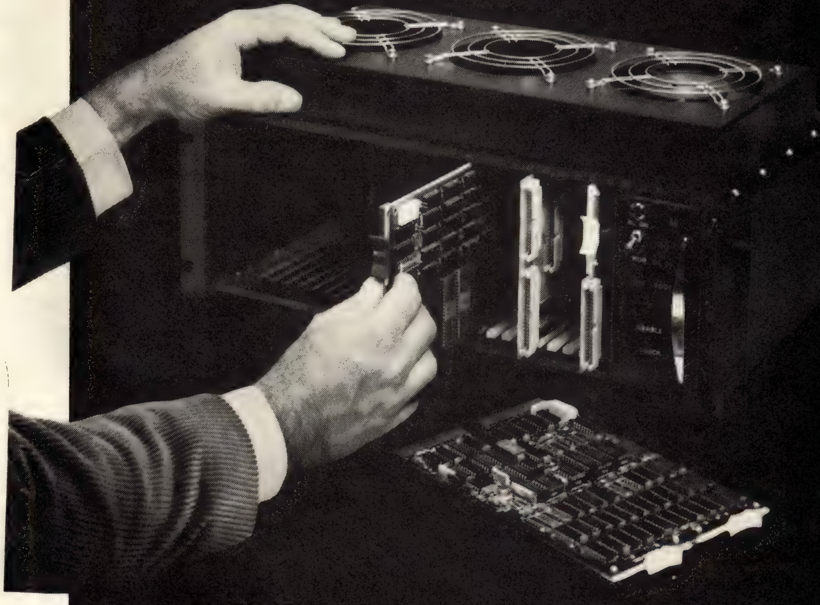
CIRCLE NO. 337

LSI-11 USERS

System MicroChassis™ eliminates hardware bottlenecks.

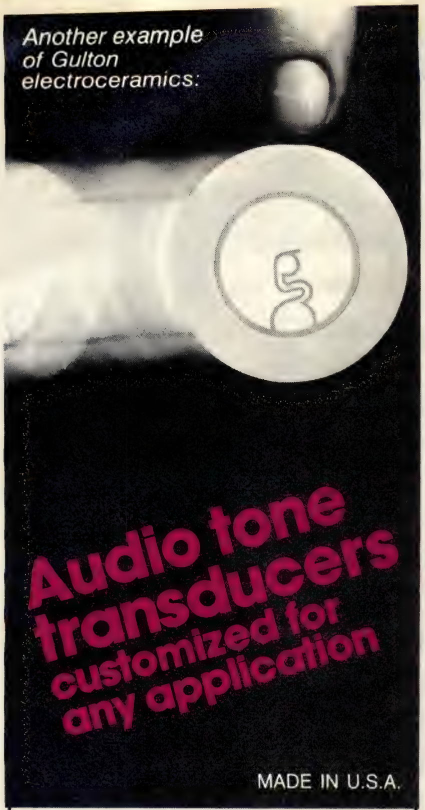
The MCC-1 provides a complete modular enclosure for dual-height LSI-11/2 or LSI-11/23 systems. Integral front control panel. High efficiency power supplies and cooling. Flexible "Q" bus backplane can accommodate up to 33 vertical cards. Easy front access card slots and cabling. Built-in control logic. Plus more. Special configurations and other systems are available.

Contact us today for complete details.



ACS DIVISION
NORTH ATLANTIC INDUSTRIES, INC.
60 Plant Ave., Hauppauge, New York 11787
(516) 582-6500

CIRCLE NO. 117



CATT® audio tone transducers can produce sound intensities from just audible to over 100 dbA with...

- low current drain
- compact sizes
- variety of configurations and frequencies
- direct TTL or CMOS drive

For detailed product and application information on these tone transducers and other piezoceramic transducers—included in our broad range of electroceramic products, call collect:
A. M. Giordano
(201) 548-2800.

Experimenter kits available for your audio tone transducer evaluation.

gulton®

Gulton Industries, Inc.
Piezo Products Division
212 Durham Avenue
Metuchen, NJ 08840
(201) 548-2800

Total 8086 system serves multiusers, multitasks

A host 8086 CPU and multiple slave 8086 processors make the Lazor 10 microcomputer a powerful, multiuser, multitasking system.

The Lazor 10 microcomputer system uses 8086 microprocessors as both the main CPU and dedicated I/O processors, so it can easily handle up to 16 users simultaneously. While it is serving multiple users, the basic 16-bit system can perform multiple tasks. It is highly modular, and various options simply plug in.

As a minimal system, the Lazor 10 comes with the main CPU, dual double-density, double-sided floppy disks (for a total capacity of 2.4 Mbytes), a disk controller, a multiport serial I/O card, a bus-control card (provides all clocking for the system and basic memory control), 64 kbytes of dynamic RAM, and a data flow and error-correcting-code (ECC) card (provides error correction on every memory cycle). Housed in a desk-like enclosure, the system includes two CRT terminals (TEC Model 570 or equivalent) and a wire matrix printer (Texas Instruments Model 810 or equivalent). The system has a main bus and two secondaries.

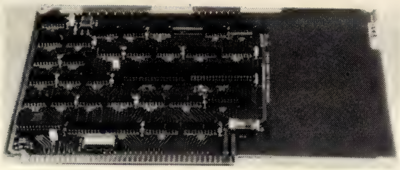
The Lazor MLX, a multilevel executive software package, controls the interrupt-driven hardware. The package provides a multitask operating system that includes task management, resource management and system access control via log-on control procedures. The resource management package helps allocate and deallocate the 1 Mbyte of addressable memory space which is available to the programmer through the 8086 CPU.

The Lazor 10 minimal system starts at about $22,500, including two CRT terminals and the printer. I/O processor and hard disk options, additional memory, serial I/O ports and floppy disk drives can also be added to the system.

Lazor Systems, 1050 Duane Ave., Suite F, Sunnyvale, CA 94086. (408) 735-1188.

CIRCLE NO. 309

Diskette controller links 4 drives to Multibus



A universal diskette controller, ZX-204, interfaces up to four double-sided, double-density standard-sized drives for as much as 4 Mbytes of storage for SBC-80 Multibus systems. The controller combines a complete drive interface and data separator circuits with a floppy disk controller chip and a Multibus interface. A DMA controller relieves a host CPU of data transfer chores. An 8219 bus arbitration chip places the ZX-204 in equal standing with other SBC-80 bus masters for control competition on the Multibus.

Zendex, 6398 Dougherty Rd., Dublin, CA 94566. Rick Main (415) 829-1323. $352 (100 qty); 6 wks.

CIRCLE NO. 338

Expansion board adds RAM to AIM/SYM/KIM

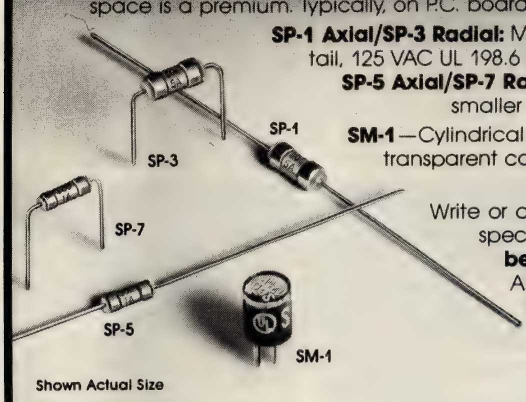
A memory expansion board, Dram Plus, adds up to 48-k of RAM and EPROM to AIM-65, SYM-1 and KIM-1 microcomputers. Both RAM and EPROM are addressable in independent 4-k segments. An on-board EPROM programmer is included. A general-purpose prototyping area facilitates addition of custom circuitry. Two 6522 chips provide 32 I/O lines, handshaking, four timers and two serial-to-parallel shift registers. The board operates on 5 V dc at 1 A and 12 V dc at 150 mA.

The Computerist, 34 Chelmsford St., Chelmsford, MA 01824. (617) 256-3649. $295 (16-k); $395 (32-k).

CIRCLE NO. 339

Get into tight spots
with SAN-O sub-miniature fuses

These quality fuses are perfect for applications where space is a premium. Typically, on P.C. boards. Available quick acting.
SP-1 Axial/SP-3 Radial: Micro (Pico) Fuses with pigtail, 125 VAC UL 198.6 Size: 7.2mm L. x 3.3mm D.
SP-5 Axial/SP-7 Radial: Same as above but smaller size: 4.8mm L. x 1.5mm D.
SM-1—Cylindrical with terminals from base, transparent cap, 125VAC. Size: 6.6mm D. x 7.4mm H.
Write or call for samples, complete specifications and pricing **Can be supplied tape and reel.** Also ask about our other fuses, fuse holders, and fuse blocks with world-wide approval. Call us to to help solve design problems, too.



Shown Actual Size

SAN-O
INDUSTRIAL CORPORATION
170 Wilbur Place, Bohemia, N.Y. 11716
(516) 567-5556 • TEX: 510-228-7701

SAN-O Fuses meet worldwide standards
BS UL CSA SEMKO CB MITI

© 1980 LH1

CIRCLE NO. 119

Terminals?
We do it – your way

Controllers
Board Sets
Controllers, Keyboards, and Terminals
Custom Boards
Special Systems

Sound interesting? Call us.

ADI
Applied Dynamics International
3800 Stone School Road
Ann Arbor, Michigan
48104
Telephone: (313) 973-1300
Telex 230238 APP DYNINT ARB

CIRCLE NO. 120

Smart floppy controller handles CPU chores

An intelligent floppy disk controller, FDC-I, contains a CPU (Z80A), I/O and memory, the functions normally required in a microcomputer system. The S-100 card accommodates three 5-1/4 in. or four 8-in. drives. On-board features include two parallel ports, two serial ports, 8-kbyte memory capacity in any combination of EPROM, ROM or RAM, an Intel-type 2716 programmer and a timer chip. CP/M, Famos and Oasis DOS are available.

Teletek, 9767F Business Park Dr., Sacramento, CA 95827. (916) 361-1777. **CIRCLE NO. 340**

SCHAFFNER

World's Most Approved RFI/EMI SUPPRESSION FILTERS

APPROVALS: UL/CSA/VDE SEV/DEMKO/SEMKO
In Full Compliance With FCC Regulation 79-555/14686

DELIVERY FROM STOCK TO 2 WEEKS IN QUANTITIES UP TO 1,000 ON ANY CATALOG ITEM!

Manufactured in Switzerland by
SCHAFFNER
. . . The Name That Stands For Highest Quality

Sold Exclusively in the U.S. by
Power Dynamics, Inc.
177 Valley Street, South Orange, New Jersey 07079
(201) 762-6886 Telex: 666173

Free Engineering Handbook Available

CIRCLE NO. 121

Memory boards expand LSI-11 data storage

Memory add-in cards, LSI 11/16 and 11/32, boost the data storage capacity of DEC's LSI-11 and PDP-11 series computers. The boards plug into any option slot and are totally hardware and software compatible. Either 16-k × 16 or 32-k × 16 memory can be selected, both with automatically-generated, internally-distributed refresh. Address switches allow starting addresses to be assigned on any 4-k boundary. Write access time is 170 ns; read access time, 375 ns. The boards operate from 5 and 12 V dc and measure 9 × 5.2 in.

Lazor Systems, 1050 E. Duane Ave., Suite F, Sunnyvale, CA 94086. (408) 735-1188. $480 (16-k); $620 (32-k) (10 qty); 4 wks.

CIRCLE NO. 341

Single-board μC mates to Rockwell 65 bus

A single-board microcomputer, CSB 2, plugs into a Rockwell system 65 bus standard. The board includes a 6502 microprocessor, 2-kbytes of static RAM, four sockets for 2716, 2732 or 2764 EPROM, a VIA (6522), a PIA (6520) and an ACIA (6551). The board gives 30 I/O lines, 10 buffered output lines, two interval timers, a serial to parallel-parallel to serial shift register, input latching on peripheral ports, serial I/O (RS-232C) with speed ranges, selectable under software control, from 110 to 19,200 baud and up to 32 kbytes of EPROM space. All EPROM/RAM addresses are switch selectable. CSB 2 requires +12 V at 50 mA, −12 V at 50 mA and +5 V at 900 mA.

Compas Microsystems, 224 S.E. 16th St., Ames, IA 50010. (515) 232-8187. $395.

CIRCLE NO. 342

Take a close look at the Houston CØMPLØT® CPS-14 & 15

You'll see the real meaning of plot quality.

Drafting-like plot quality—that's the whole idea behind the new CPS-14 and 15 digital plotting systems. Make us prove it. Just take a look at the output from the CPS-14 and 15...you'll see plot quality comparable to or exceeding that of competitive plotters costing twice as much.

Four pens and a dual microprocessor controller with superior firmware functions combine to make this the ideal plotter for drafting, civil engineering, numerical control, mapping...any application where plot quality is vital.

Prices for the 22″ wide CPS-14 start at only \$9,950*. Prices for the 34″ CPS-15 start at \$12,950*.

Let us send you a free sample plot. See for yourself the superior plot quality provided by these newest members of the CPS family. Call or write Houston Instrument, One Houston Square, Austin, Texas 78753. (512) 837-2820. For rush literature requests persons outside Texas call toll free 1-800-531-5205.

houston instrument | DIVISION OF BAUSCH & LOMB

"the graphics company"

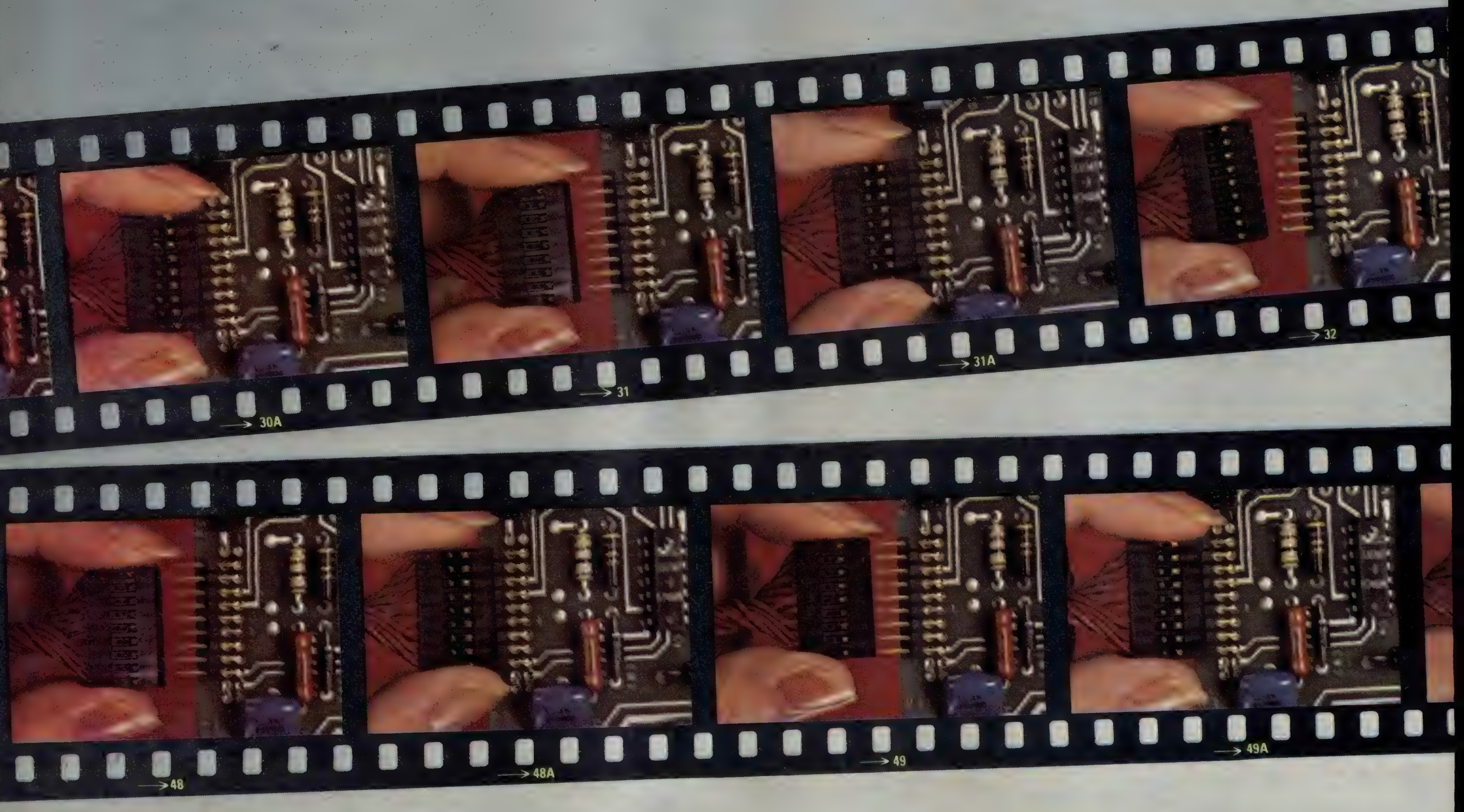
See us at the NCC Show in Booth 1539.

Circle No. 122 for Literature
Circle No. 293 to have Representative call

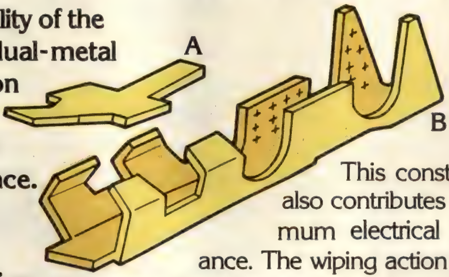
*U.S. Domestic Price Only

®Registered Trademark of Houston Instrument

Berg's 0.025" PV™ receptacle
And do it time...after tim



The secret to the durability of the "PV" lies in our unique dual-metal design. This combination of metals results in optimum mechanical and electrical performance.



A. The heat-treated beryllium copper spring maintains constant mechanical pressure on pins. Even after repeated insertion/withdrawal cycling.

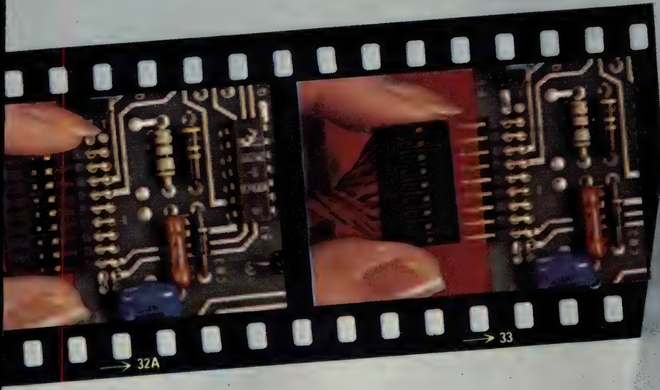
This constant force also contributes to maximum electrical performance. The wiping action between pin and contact area, created by high normal force during mating, cleans the contact surfaces of oxides.

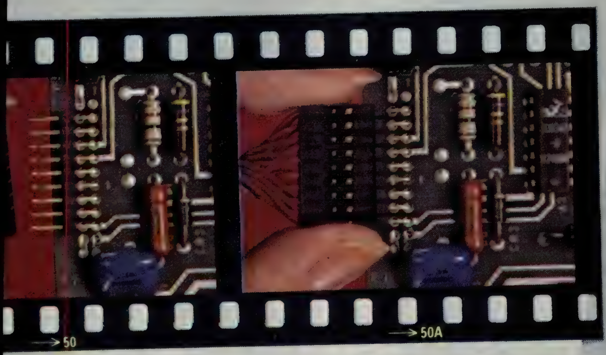
B. The brass body, working with the spring, provides optimum conductivity—an excellent 5 milliohms contact resistance or less. And brass facilitates crimping and extends application tool life.

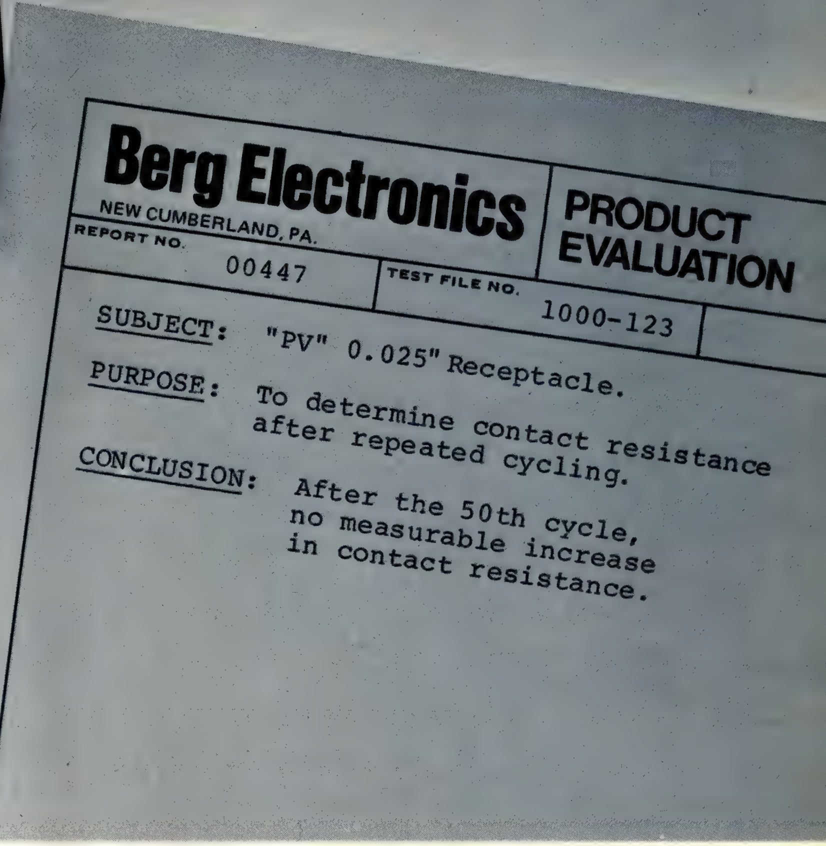
The "PV" line allows wide design flexibility.

A choice of three spring thicknesses are available to help meet specific *insertion*/withdrawal force requirements. There are four terminal variations in crimp-to-wire sizes from AWG 18-36. The wide variety of

deliver low contact resistance.
..after time...after time...







Berg Electronics
NEW CUMBERLAND, PA.

PRODUCT EVALUATION

REPORT NO. 00447
TEST FILE NO. 1000-123

SUBJECT: "PV" 0.025" Receptacle.

PURPOSE: To determine contact resistance after repeated cycling.

CONCLUSION: After the 50th cycle, no measurable increase in contact resistance.

types and sizes, and the option of several gold or tin-lead platings, offer maximum design flexibility.

The Berg "PV" is the heart of the most complete 0.025" interconnection system available today. The BergCon™ system.

The "BergCon" system consists of a variety of mateable terminations for board-to-board, cable-to-board, or cable-to-cable packaging:

- BergStik™ pins, conveniently molded in plastic, can be manually inserted into P.C. boards for on-line production without a machine.
- Standard housings allow simultaneous connection of as many as 72 "PV" terminated connectors.
- Low cost, easy to load hand tools available through distributors make the "BergCon" system practical for even the lowest-volume user. Or a low cost air-operated applicator is available from Berg.
- And the entire "BergCon" system is Underwriters recognized.

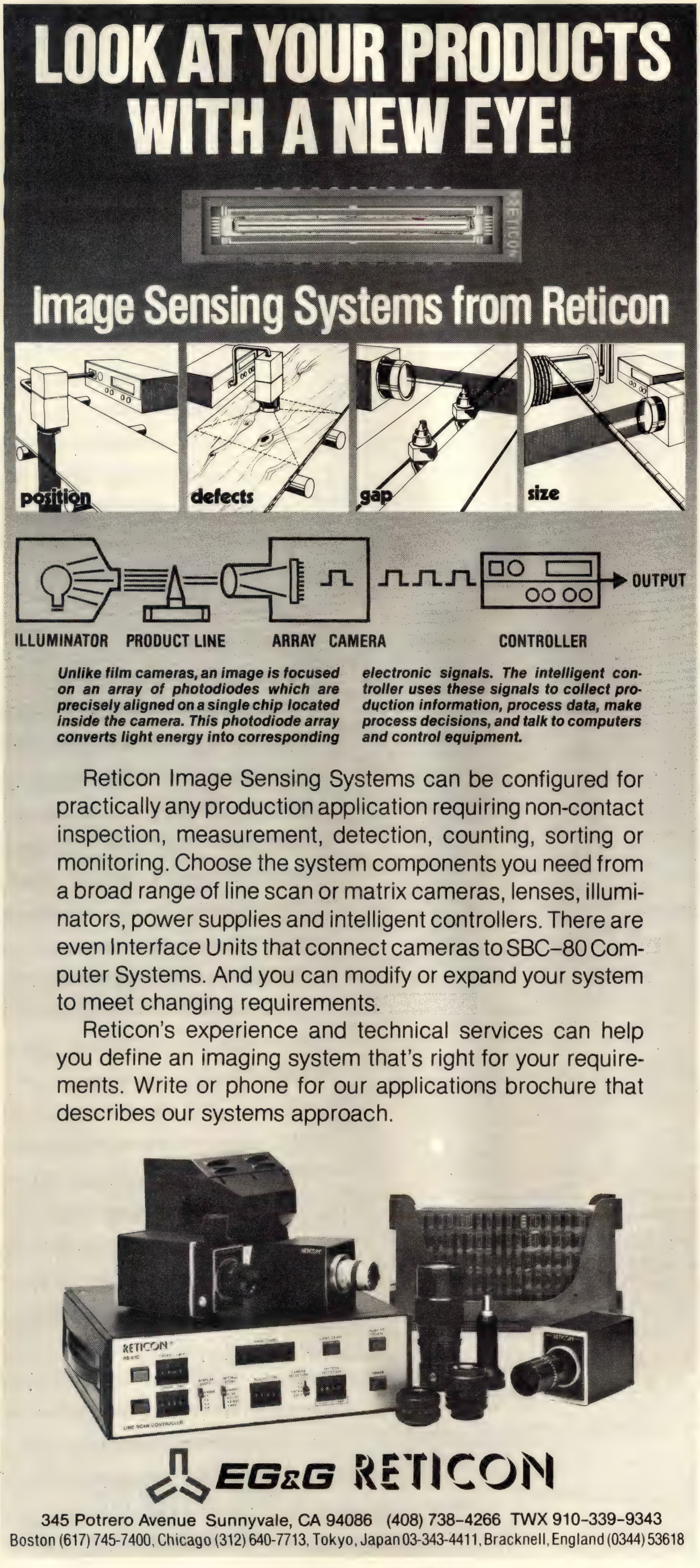
For detailed information on the complete "BergCon" system, write or call: The Du Pont Company, Berg Electronics Division, New Cumberland, Pennsylvania, 17070, Telephone: (717) 938-6711. Or contact your nearest Berg Electronics connector distributor.
In Europe: 's-Hertogenbosch, Netherlands, Telephone: (31) 73-215255.

Innovations for Electronics

Berg Electronics

DU PONT
REG US PAT & TM OFF

CIRCLE NO. 123



LOOK AT YOUR PRODUCTS WITH A NEW EYE!

Image Sensing Systems from Reticon

Unlike film cameras, an image is focused on an array of photodiodes which are precisely aligned on a single chip located inside the camera. This photodiode array converts light energy into corresponding electronic signals. The intelligent controller uses these signals to collect production information, process data, make process decisions, and talk to computers and control equipment.

Reticon Image Sensing Systems can be configured for practically any production application requiring non-contact inspection, measurement, detection, counting, sorting or monitoring. Choose the system components you need from a broad range of line scan or matrix cameras, lenses, illuminators, power supplies and intelligent controllers. There are even Interface Units that connect cameras to SBC–80 Computer Systems. And you can modify or expand your system to meet changing requirements.

Reticon's experience and technical services can help you define an imaging system that's right for your requirements. Write or phone for our applications brochure that describes our systems approach.

EG&G RETICON

345 Potrero Avenue Sunnyvale, CA 94086 (408) 738-4266 TWX 910-339-9343
Boston (617) 745-7400, Chicago (312) 640-7713, Tokyo, Japan 03-343-4411, Bracknell, England (0344) 53618

CIRCLE NO. 124

Smart disk controller mates to TI-990 computer

A single-board, high-density disk drive controller, MSC-1990, gives control of up to three drives to the TI-990 minicomputer. Using a microprocessor for functional compatibility with the existing TI operating system, the controller is totally software transparent. Features include hardware error correction code (ECC) to detect and correct single-burst data errors of up to eleven bits per sector. The errors are corrected within the controller's full-sector buffer before data transfer to the host is initiated. Automatic retry capability is used when a seek error is encountered. Such an error initiates an automatic recovery sequence which includes recalibrating the drive and repeating the last operation.

Microcomputer Systems, 432 Lakeside Dr., Sunnyvale, CA 94086. (408) 733-4200.

CIRCLE NO. 343

Card gives 32 I/O lines for use on the STD BUS

A STD BUS-compatible I/O card, 7605, provides four 8-bit, TTL-compatible ports for a total of 32 lines. Each line is programmable for input or output with readback. The card decodes eight address lines with provision for expansion and memory mapping. An on-card jumper allows a user to map, anywhere in the 256-port address field, the four consecutive I/O port pair addresses occupied by the card. Ports are accessed via two 40-pin latched connectors with 0.025 in.^{2} post headers. The card requires a single 5-V supply.

Pro-Log, 2411 Garden Rd., Monterey, CA 93940. (408) 372-4593. $225.

CIRCLE NO. 344

Faster memory speeds PROM emulator

The Step-2 firmware integration and test station has received a 20 to 30% speed boost from two new writable control stores.

Thanks to a writable control store (WCS) board with an access time of either 36 ns (1 kiloword) or 50 ns (4 kilowords), the latest generation of Step-2 firmware integration and test stations is some 20 to 30% faster than the previous one. The speed increase tracks today's real-time testing needs, according to Step Engineering, since such peripherals as Winchester disk drives, which must be tested at full speed, are constantly getting faster.

The Step-2 works with a host computer from which it downloads microcode into its WCS. The instrument then emulates the PROMs of a bit-slice or other processor. It allows fast and easy English-language editing of code. The portable instrument also contains a built-in logic analyzer that can store 250 32-bit words.

The new 1-kiloword MEM-32F and 4-kiloword MEM-128F writable control stores have integral real-time breakpoint comparators, read/write operation, and hardware bit mapping. They offer a choice of fast, field-configurable interfaces: output latches, buffers, and registers.

The new WCS modules can be interchanged with earlier units in the field.

The Step-2 is compatible with both bit-slice microprocessors and ROM-based logic. It will work with the 2900 and 8X300 bipolar microprocessors and with their associated 8X02 and 29116 controllers, among others.

According to the manufacturer, the general-purpose PROM emulator pays for itself by eliminating numerous PROM-burning iterations and single-use WCS designs. It saves design time by speeding up the edit-test cycle and provides run, halt, and step modes for thorough testing of the processor under study.

Delivery time for the MEM-32F and MEM-128F is 45 days.

Step Engineering, P.O. Box 61166, Sunnyvale, CA 94088. (408) 733-7837. **CIRCLE NO. 450**

Berg's 0.025" PV™ interconnection system is available through these leading distributors:

ARIZONA
Phoneix
Weatherford
602-272-7144
CALIFORNIA
Anaheim
Weatherford
714-634-9600
Belmont
LoDan
415-592-4600
Glendale
Weatherford
213-849-3451
Inglewood
Force Electronics
213-776-1324
Palo Alto
Weatherford
415-493-5373
San Diego
Weatherford
714-278-7400
COLORADO
Englewood
Weatherford
303-770-9762
CONNECTICUT
Norwalk
Harvey
203-853-1515
FLORIDA
Orlando
Hammond
305-849-6060
ILLINOIS
Arlington Heights
LoDan
312-398-5311
INDIANA
Fort Wayne
Fort Wayne Electronics
219-423-3422
Indianapolis
Graham
317-634-8202
KANSAS
Kansas City
Tennant
913-287-2100
MARYLAND
Baltimore
Resco/Baltimore
301-823-0070
Beltsville
Resco/Washington
301-937-9100
MASSACHUSETTS
Lexington
Harvey
617-861-9200
MINNESOTA
Minneapolis
Aero Space
Computer Supplies
612-884-4725
NEW JERSEY
Pinebrook
Harvey
201-227-1262
NEW YORK
Binghamton
Harvey
607-748-8211
Commack
Conco Electronics
516-543-8300
W. Henrietta
Harvey
716-334-5920
Woodbury
Harvey
516-921-8700
NORTH CAROLINA
Greensboro
Hammond
919-275-6391
OHIO
Cincinnati
Graham
513-772-1661
Cleveland
CAM/Ohio
216-461-4700
PENNSYLVANIA
Philadelphia
Almo
215-698-4000
Pittsburgh
CAM/RPC
412-782-3770
SOUTH CAROLINA
Greenville
Hammond
803-233-4121
TEXAS
Austin
CSI
512-837-8922
Dallas
CSI
214-357-6511
Houston
CSI
713-771-7237
WASHINGTON
Seattle
Weatherford
206-575-1340

DU PONT
REG U.S. PAT & TM OFF

Display assemblies interface easily

Intelligent display assemblies on printed-circuit cards hold up to eight four-character alphanumeric modules. The IDA-2416-32 display 32 characters, and the IDA-2416-16 provides 16 characters. Writing a character into the IDA from the board edge takes about 600 ns—adequate speed for man-machine interfacing.

Each DL-2416 display module contains four 0.160-in. upper-case characters formed by 16-segment LEDs. Its internal circuit generates characters and handles ASCII decoding. The 8.8 × 2.3-in. IDA PC cards hold buffers for the data and address buses and a special user-programmable enable-decoding section.

The IDA boards hold up to eight four-character display modules, and also contain buffers and decoding logic to simplify the interface.

With the enable decoder, multiple IDAs can be used in a system; each could respond to the same or different signals.

Three of the control inputs (Write, Clear, and Board Select) have Schmitt-trigger inputs to prevent false triggering. All interfacing to the board, not including power, is through a 26-pin Berg (P/N 65496-013) ribbon-cable connector. Power is 5 V at about 750 mA (all segments on) for a 32-character board and goes through a four-pin AMP connector.

In 100 unit quantities, the IDA 2416-32 will sell for $250 and the IDA 2416-16 will be priced at $150. Delivery of the samples is from stock.

Litronix, 19000 Homestead Rd., Cupertino, CA 95014. (408) 257-7910.

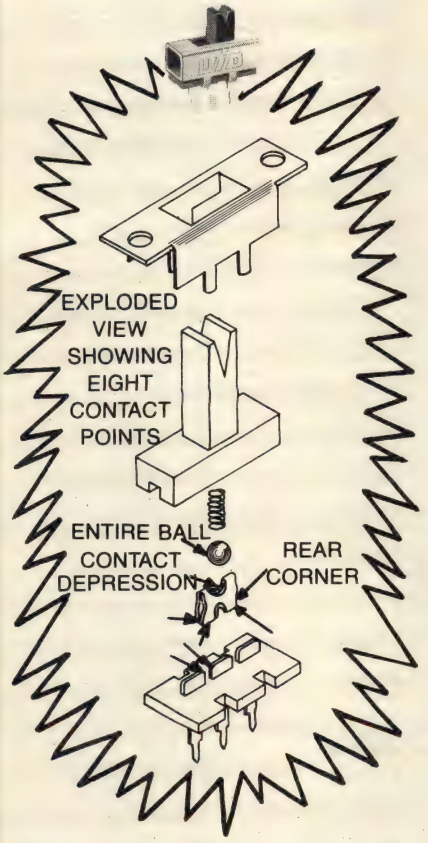
CIRCLE NO. 307

Memory uses magnetic cores for up to 1 Mbyte

M/Core, a mass-memory system using magnetic cores, provides capacities of up to 1 Mbyte in a 9-in. rack-mount assembly. The basic building block of the system is a 128 kword × 18-bit core memory module contained on a single, plug-in PC board.

Alpha Data, 20750 Marilla St., Chatsworth, CA 91311. (213) 882-6500.

CIRCLE NO. 431


EXPLODED VIEW SHOWING EIGHT CONTACT POINTS
ENTIRE BALL CONTACT DEPRESSION
REAR CORNER

You've Seen The Rest - Now See The Best!

UID's MA-012 SLIDE SWITCH

△ Compact - Dual Wipe Construction
△ Unique High Reliability In A Commercial Slide Switch

For all of its features, this switch is still available at the low cost of . . .

Only 20¢ each per 10,000 Quantity

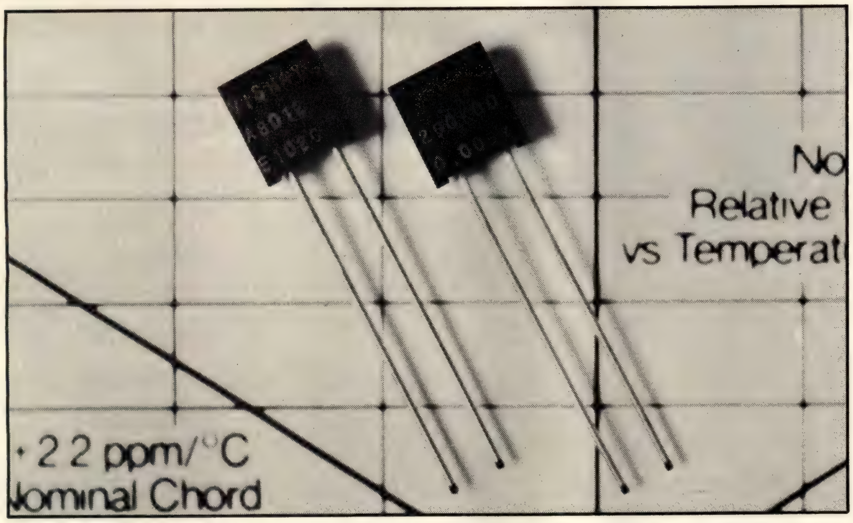
. . . and orders are being accepted at current pricing.

Call Walt Dinneen, Switch Product Manager For FREE SAMPLE

AMF
Electro-Components Division
RCL and UID Products
General Sales Offices: 2713 Gateway Drive, Pompano Beach, Florida 33060
305/973-8620

CIRCLE NO. 126

Precision resistors move up to 250 kΩ



The E102 series from Vishay offers precision resistance values up to 250 kΩ on a single chip in a 0.302 × 0.326 × 0.105-in. molded case.

Improved processing makes Vishay's Bulk Metal resistors the first high-precision resistors with values above 100 kΩ to be manufactured on a single chip. As a result, the E102C series will offer up to 250 kΩ with the same tight tolerances and tempcos, and in the same small package as other components in Vishay's 102 series.

Resistance values span 100 Ω to 250 kΩ with tolerances from ±1.0% to as low as ±0.005%. The nominal temperature coefficient of resistance is 0.6 ppm/°C from 0 to 25 C and −0.6 ppm/°C from 25 to 60 C, and TCR tracking on selected parts can be as tight as 0.5 ppm/°C throughout the full temperature range.

Like other 102-series parts, the E102C resistors feature load-life stability of 0.05%. For 100 to 150-kΩ resistors in the E102C series, full rated power is the same; 0.3 W at 125 C (for 2000 hours). For 150 to 250-kΩ resistors, however, the power dissipation is somewhat lower: 0.2 W and 85 C for 2000 hours. For power handling, however, Vishay recommends its precision power plate resistors, which can easily handle 3 W at 125 C in free air and provide resistance values of up to 5 kΩ. Even so, the E102C resistors will still perform exceptionally well in critical circuit applications such as avionic control systems, CRT displays, laboratory and scientific instruments, and other ultraprecise electronic measurement and control equipment.

Other featues of Vishay's Bulk Metal technology include extremely low current noise (0.025 μV rms/V of applied voltage), and low thermal EMF (0.5 μV/°C maximum) at the chip-to-lead junction. These stem from Vishay's special wrap-around "paddle lead" construction.

The resistor chips come in a 0.302 × 0.326 × 0.105-in. molded case, and are available from stock to eight weeks.

Vishay Resistive Systems Group, 63 Lincoln Highway, Malvern, PA 19355. Tony Troianello (215) 644-1300

CIRCLE NO. 304

Concentric shaft switch saves front-panel space

A subminiature rotary switch with dual concentric shafts doubles switching capability of Series 80 switch bodies. Front-panel space is saved using the 13/16 × 9/16 in. switch. Index angles of 30, 60 and 90° are available in a wide variety of switching configurations. Several are offered with BCD outputs. A maximum of 10 modules per shaft can be obtained, totaling either three or five decks, depending on switching configuration. Inner shaft diameter is 0.125 in.; outer shaft diameter, 0.188 in.; bushing diameter, 0.375 in. Series 80 rotary switches are available with solder lug or PC terminals. A rectangular design provides maximum support for output PC pins, making them less susceptible to breakage than round designs. Inline PC pins are on 0.1-in. centers.

Stackpole Components, P.O. Box M, Farmville, VA 23901. (804) 392-4111.

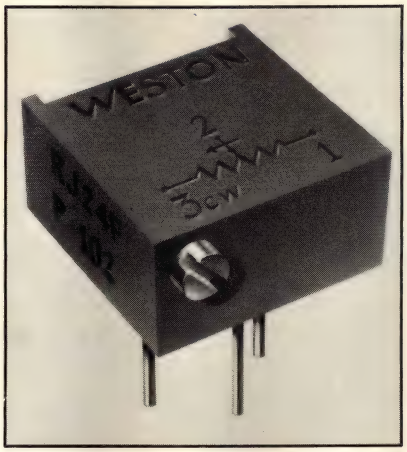
Electro: 2341 **CIRCLE NO. 437**

Detector finds weak signals at 750 to 1100 nm

A reach-through avalanche photodetector picks up weak light signals in the spectral region of 750 to 1100 nm. The device is suitable for optical range finding and fiber optic communications systems. The light-absorbing region of the device is in excess of 100 microns for effective absorption of near IR radiation. This results in a high quantum efficiency of 60% at 900 nm and 15% at 1064 nm. Absence of a slow component means the sensitivity of the device is independent of the modulation frequency, subject to transmit-time limitation.

Centronic, 1101 Bristol Rd., Mountainside, NJ 07092. (201) 233-7200. **CIRCLE NO. 438**

Trimmers make stronger, lower-cost contacts



High-volume automatic assembly will strengthen the pin-to-substrate contacts as well as lower the cost of mil-spec cermet trimmers announced by Sangamo Weston's Components and Controls Div. The MIL-RJ24 trimmers employ swaged pin-contact terminations, which provide better electrical and mechanical pin-to-substrate contact than traditional termination techniques such as clipping, soldering and welding.

The new series is 3/8 in. square, is available with resistances from 10Ω to 1 MΩ and meets the requirements of MIL-R-22097 and MIL-R-39035. The contact-resistance variation is better than ±3% and temperature coefficient of resistance is better than ±100 ppm/°C; in fact, ± 50-ppm tempcos may be specified.

The mil-spec-qualified trimmers can be counted on to function reliably between −55 and +150 C. After 250 hours at 150 C, in fact, total resistance shift will be less than ±2%. In addition, a ten-day humidity cycle will produce a less than ±2% shift, while end-of-life testing should produce less than ±3% total shift.

This high reliability stems from epoxy seals on specialized high-temperature (150-C) Valox. The shafts of the RJ24 trimmer, in addition, are press-fit, which frequently provides a better seal than traditional "O" ring seals.

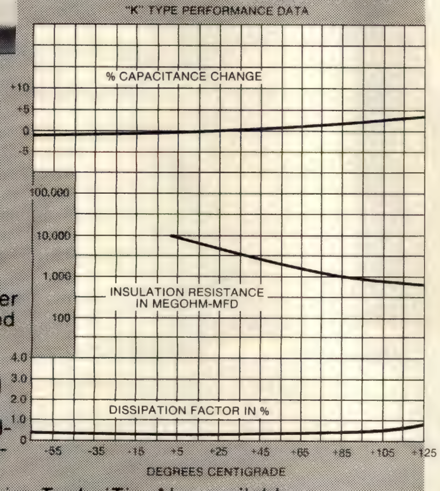
The devices will be available in three configurations—P, W and X —for right-angle, upright, or right-angle-upright PC-board mounting.

Prices for the RJ24 series will depend on configuration and quantity. Delivery is from stock to six weeks.

Weston Components and Controls, Archbald, PA 18403. Tom Chleboski (717) 876-1500.

CIRCLE NO. 303

Small is Beautiful with CUSTOM K Series Mica Capacitors



MAXIMUM VOLUMETRIC EFFICIENCY ON HIGH VOLTAGE APPLICATIONS —TO 75 KV

Compact, long-life K Series capacitors made from mica paper dielectric impregnated with epoxy formulation.

Potential volume and weight reductions of 30 to 50% from standard polyester-impregnated design.

Write for FREE K Series TechniTip. Also available, C Series Mica for energy storage, and T Series Film for high temperature applications.

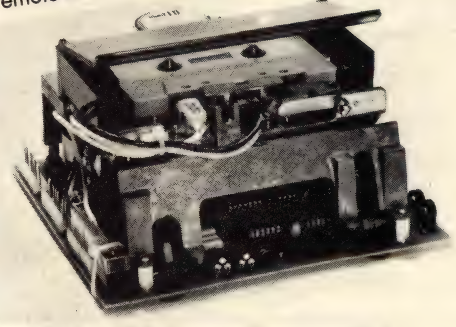
CUSTOM

CUSTOM ELECTRONICS, INC.
4 Browne St., Oneonta, NY 13820
PH: 607-432-3880 TWX: 510-241-8292

CIRCLE NO. 86

PHI·DECK®
Cassette Transports

•Fully remote controllable •Four-motor design •Cast chassis



New Phi-Deck Electronics

- Motion Control . . . Minimum complexity, Maximum performance.
- Digital . . . Read/Write and Motion Control on one board. Recording density to 1600 FRPI.
- Analog . . . Two channel Record/Play and Motion Control on one board.

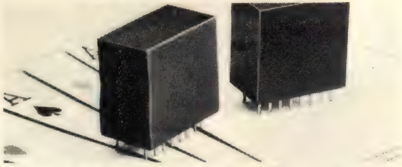
Write or call for information on our specially priced Design Kits and OEM Modules featuring PHI-DECK electronics.

4605 N. Stiles P.O. Box 18209 (405) 521-9000
Oklahoma City, OK 73154 TWX: 910-831-3286

Triple i Incorporated

CIRCLE NO. 127

Darlington quads switch up to 8 A in DIP

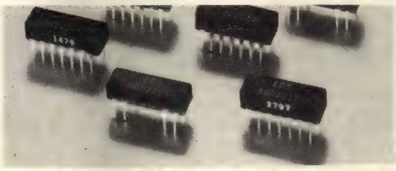


High-current power Darlington transistor quads provide peak collector currents to 8 A. ND5 and PD5 types have ratings of 5 A per element while ND8 and PD8 series devices are 8-A types. All units are available with collector voltage ratings to 100 V. Gain is typically over 1000 at 30% of maximum current. The DIP housing includes an internal heat sink, permitting an overall package dissipation of 3 W.

Micrologic Components, 54 Freeman St., Newark, NJ 07105. (201) 344-1029. $3.00 to $5.00 (5 A); $3.60 to $6.00 (8A) (100 qty); stock to 6 wks.

CIRCLE NO. 345

DIP reed relays come in Form A, B or C

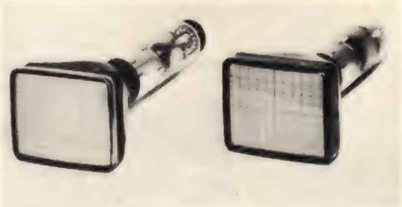


A line of DIP reed relays, available in Form A, B or C configurations, can be driven from standard TTL logic. Standard operating voltages of 5, 6, 12 and 24 V are offered in all versions. Coil resistances range from 200 to 500 Ω in the 5-V units an 1200 to 2400 Ω in 24-V models. Contact rating is 4 W for Form C versions. Standard relays include Forms 1A, 2A, 3A, 4A, 1B, 2B, 1C and 2C. Electrostatic shielding and internal clamping diode options are available.

Electro Design Systems, 401 W. 35th St., National City, CA 92050. (714) 420-2351.

CIRCLE NO. 346

Acceleration mesh results in compact CRT



A domed, post-deflection acceleration mesh, used on two 5-in. rectangular oscilloscope CRTs, results in a compact, short tube. The CRTs are only 12-in. long, including pins. An internal graticule, measuring 8 × 10 cm, is included. Type 140CGB31 offers a frequency response of 30 MHz, while the 140BHB31 is good to 50 MHz. Both tubes use P31 phosphor.

Panasonic, One Panasonic Way, Secaucus, NJ 07094. Bill Parkin (201) 348-7271. $85 (140CGB31); $140 (140BHB31) (1000 qty); 17 wks.

CIRCLE NO. 347

Sunlight Readable Pushbutton Switches

Easy Reader—Lighted legend is clearly legible in 10,000 footcandle ambient light. Eliminated is the problem of loss of readability due to reflection of bright ambient light. Illumination is uniform...no hot spots, even when dimmed for night viewing.

Dead front panel—Unlighted display has flat, dead front panel. Hidden message does not appear energized in 10,000 footcandle ambient light.

Wide selection—Only Stacoswitch offers a full line of Sunlight Readable Switches and Indicators with choice of mounting method, circuitry, switch action, and type of termination. Series 80 Sunlight Readable Switch/Indicators are dependable and very affordable ...the perfect choice for those applications requiring positive legibility even when viewed under bright ambient light.

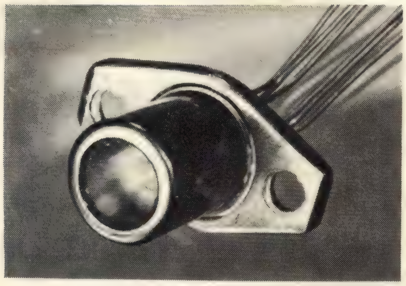
STACOSWITCH
a STACO, INC. company
1139 BAKER STREET, COSTA MESA, CALIF. 92626
(714) 549-3041 TWX: 910/595-1507

Write today for **FREE descriptive catalog.**

Other STACO Company products: Custom Transformers, STACO TRANSPOWER, Richmond, Indiana; Variable Transformers, STACO ENERGY PRODUCTS, Dayton, Ohio.

CIRCLE NO. 128

IR detector aids thermal imaging



A single-stage, thermoelectrically-cooled IR detector, Series 1000, finds use in thermal imaging, remote sensing and emission analysis applications. The range of devices have a spectral response from 1 to 5 μm, with a maximum response at 4.1 μm. Typical peak detectivity value is 7.5×10^9 cmHz$^{1/2}$W^{-1}. Each unit includes a thermistor-sensing element for precise control of detector temperature during operation. Cooling power required is 2 A at 1.2 V; power dissipation is approximately 2 W. Type 1001 and 1002 detectors come in TO-5 housings; 1003 and 1004 are furnished in TO-37 packages.

Barnes Engineering, 30 Commerce Rd., Stamford, CT 06904. (203) 348-5381.

CIRCLE NO. 348

Metal-film resistors narrow tolerance to 2%

A line of metal-film resistors comes with 2 and 5% tolerance. The 1/4-W units are available in a range of 10 Ω to 1 MΩ with a tempco of ±200 ppm/°C.

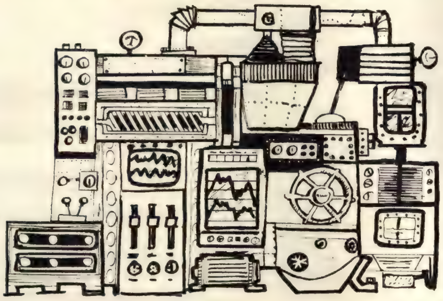
Stackpole Components, P.O. Box 14466, Raleigh, NC 27620. (919) 828-6201.

CIRCLE NO. 349

Accelerometer aids vibration testing

Miniature piezoresistive accelerometers, Series 7265, provide accurate measurements of long-duration pulses and are suited for low-level vibration testing. Their small size and light weight make them useful for flutter testing and similar applications requiring minimum mass loading. Full scale ranges from 10 to 100 g are

If It's Not in GOLD BOOK...



IT PROBABLY HASN'T BEEN INVENTED YET

When you look in the "World's Most Complete Electronics Directory" you can be confident that the product/service you are seeking will be listed there. Our editorial staff takes pride in presenting the new, the unusual—and the mundane, and in leading you to the product/service you **must** locate to enable you to do your job.

"Over 108,000 Distributed Worldwide"

Electronic Design's
GOLD BOOK
THE WORLD'S MOST COMPLETE ELECTRONICS DIRECTORY

Hayden Publishing Company Inc.
50 Essex St., Rochelle Park, NJ 07662 • 201-843-0550

NEW ... from GORDOS ...
Dry Reed Switches

MR-5508
- Dip relay compatible
- New Rhomet plating
- Long life
- Highly sensitive
- Competitively priced
- The "ultimate" reed switch
- The heart of Gordos 1A-83 series dip relay

MR-103
- Tungsten contacts
- High inrush capabilities
- Inductive load capabilities
- Capacitive load capabilities
- The heart of every Gordos 76 series "Power" relay

For complete technical data write for Gordos Reed Switch Catalog.

Gordos Corporation
250 Glenwood Ave., Bloomfield, N.J. 07003 (201) 743-6800
Gordos Arkansas
1000 N. Second St., Rogers, Ark. 72756 (501) 636-5000

available. The units are fluid-damped to protect against high-level shocks and vibrations or careless handling. All units have a shock over-range rating of 2000 g.

Endevco D.I.D., Rancho Viejo Rd., San Juan Capistrano, CA 92675. (714) 493-8181.

CIRCLE NO. 354

High-voltage transistors switch 6 A fast

High-voltage, high-speed transistors, GSTU6040, 6035 and 6030, switch inductive loads of 6 A without snubbing. Turn-off crossover time is less than 400 ns. The devices have collector-to-emitter voltages of 400, 350 and 300 V. A 4-A series is offered. Both series are packaged in TO-3 metal cases.

General Semiconductor Industries, P.O. Box 3078, Tempe, AZ 85281. (602) 968-3101. $3.10 to $3.90 (100 qty); stock to 8 wks.

CIRCLE NO. 355

Lighted switch stays readable in sunlight

A lighted pushbutton switch, MSC 580, remains readable, even in sunlight. The switch, designed for use in cockpits of military and commercial aircraft, measures 0.75 × 0.75 in. and protrudes one inch behind a panel (not including terminals). MSC 580 is offered in single or double-pole, momentary or alternate configurations and can accept up to four T1, flange-base lamps. The lighted switch section can be removed from the front panel, without use of tools, for quick bulb replacement.

Master Specialties, 1640 Monrovia St., Costa Mesa, CA 92627. (714) 642-2427.

CIRCLE NO. 356

Integral resistor/diode protects LED

A current-limiting resistor and a reverse-protection diode are built into a series of TTL-compatible subminiature LEDs, saving board space and reducing component counts. A 5-V source directly drives the standard red HLMP-3105, the high-efficiency red HLMP-3600, the yellow HLMP-3650 and the green HLMP-3680. The HLMP-3112, a standard red device, interfaces to a 12-V source. The panel-mountable devices come in T-1-3/4 packages with sturdy 0.64 mm^2 leads suitable for wrap-wiring. Viewing angle is 90°.

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 857-1501. $0.36 (3105, 3112); $0.45 (3600, 3650, 3680) (1000 qty); stock.

CIRCLE NO. 357

GORDOS
OFFERS . . . Over 400
Variations
of
Mercury
Tilt
Switches

For complete details, write today for Gordos 14 page Mercury Tilt Switch catalog — No. MTS201

Gordos Corporation
250 Glenwood Ave., Bloomfield, N.J. 07003 (201) 743-6800
Gordos Arkansas
1000 N. Second St., Rogers, Ark. 72756 (501) 636-5000

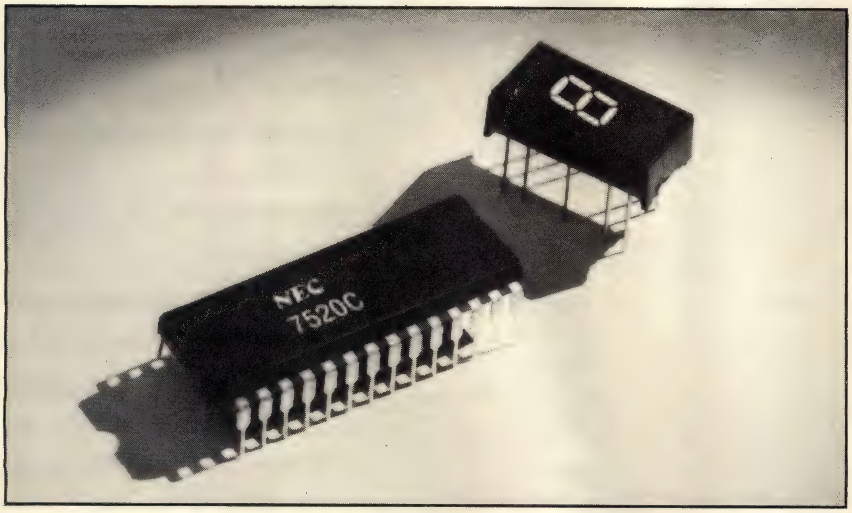
NEW . . . from
GORDOS

- GORDOS has the products
- GORDOS has the product reliability
- GORDOS has the product literature

- Reed Relays Series 76
- Dip Reed Relays
- Reed Switches
- Dry and Mercury Wet Reed Relays
- AC Solid State Relays
- Reed Relays Series 65/66
- Mercury Switches
- 1/0 Modules

Gordos Corporation
250 Glenwood Ave., Bloomfield, N.J. 07003 (201) 743-6800
Gordos Arkansas
1000 N. Second St., Rogers, Ark. 72756 (501) 636-5000

Single-supply 4-bit μC packs display controller



The first of a family of pMOS μCs will sell for less than $2.50 in large quantity. Future family members will have larger memories and instruction sets.

A single-supply, 4-bit microcomputer from NEC Microcomputers packs a programmable display controller that can directly drive LED displays with up to eight-digits, of eight segments each. Designed using pMOS technology, the μPD-7520 can operate from supply voltages of −6 to −10 V. An internal register of the display controller holds a 4-bit control word that determines the number of digits (4, 5, 6 or 8) controlled by the μC.

In addition to the display controller, the μC includes 768 bytes of ROM space, 48 nibbles of RAM, a two-level subroutine stack, on-chip clock circuits, ten I/O lines, and 14 display-control lines. Capable of executing 47 basic instructions, the processor operates with a 20-μs instruction cycle time and typically has a 300-kHz clock frequency.

The display-controller section has two operating modes—one as the display controller, and the other as an 8 and a 6-bit parallel port. When used for LED driving, the port segment lines can handle a typical current of −10 mA for an output current high, and the digit-drive lines can handle −48 mA, for both a −9 V supply voltage and a V_{OH} level of −2 V.

The μPD-7520 is the first of a pMOS family of μCs coming from NEC Microcomputers. Capable of executing 47 of the μCOM-75 family's instructions, the μPD7520 makes available memory transfers, bit manipulation, auto increment/decrement, table look-up, constant table formulation, input of command strings, and multiple branches. What's more, the μC does all this with only one control pin aside from its dedicated I/O lines—a reset control.

The ten I/O lines consist of one 4-bit input port, one 2-bit output port (capable of driving a piezo element), and one 4-bit I/O port, two of whose lines double for two-digit drive lines if required for the seventh and eight digits.

NEC Microcomputers, 173 Worcester St., Wellesley, MA 02181. (617) 237-1910.

CIRCLE NO. 308

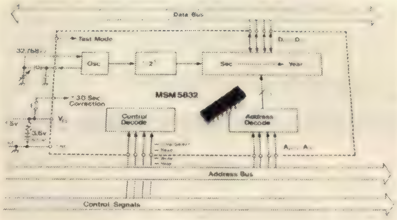
CMOS clock circuit sounds musical alarm

A CMOS timekeeping circuit, SCL5470LH, not only keeps time, but sounds its alarm with a musical multi-tone melody. The circuit easily interfaces with standard, 6-digit LCD watch and clock displays and simultaneously shows hours, minutes, day-of-the-week and either seconds or date. Timekeeping can be in a user-selectable 12 or 24-h mode.

Solid State Scientific, Commerce Dr., Montgomeryville, PA 18936. (215) 855-8400. $1.70 (1000 qty).

CIRCLE NO. 358

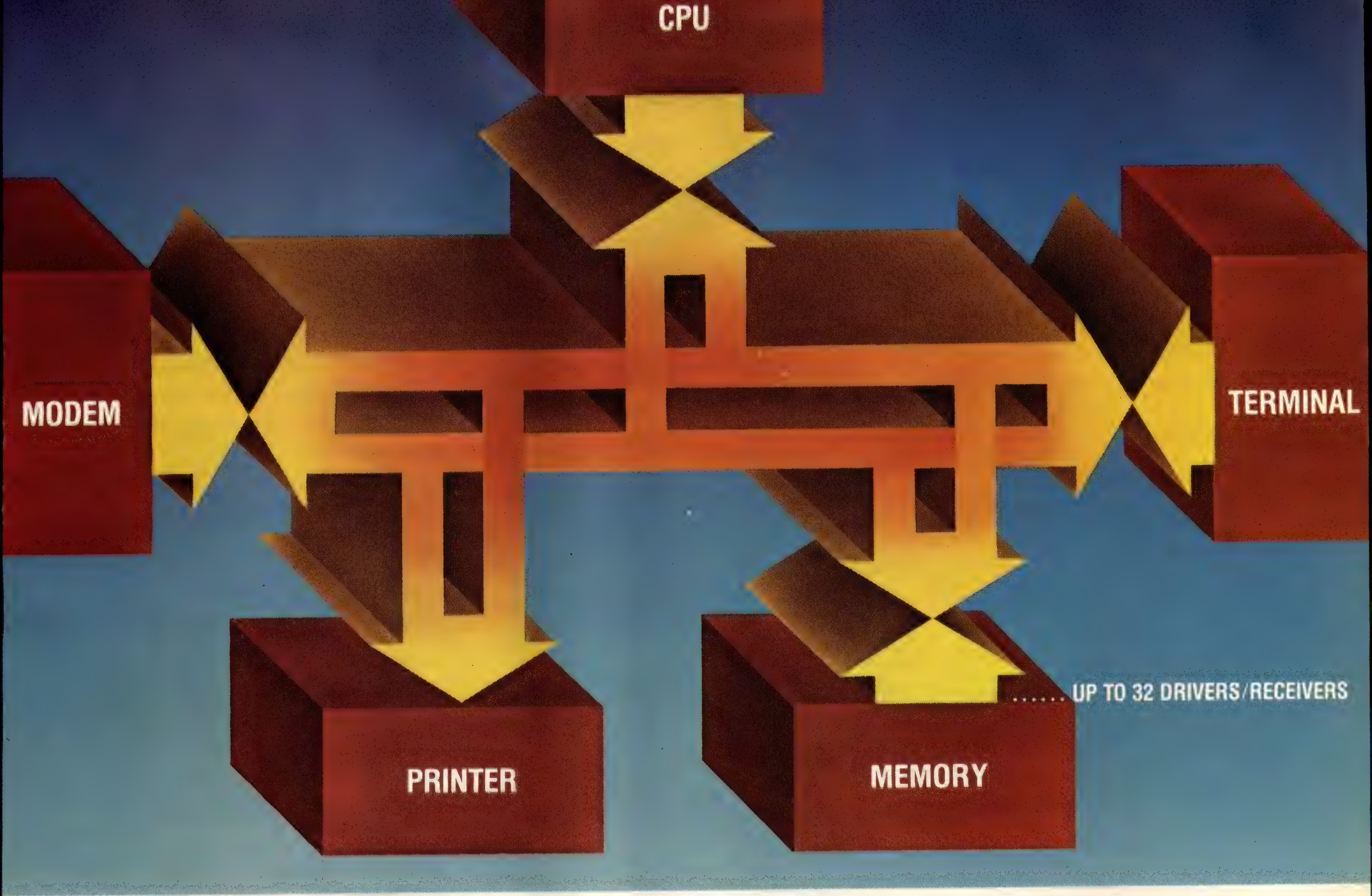
Real-time clock chip keeps μPs/μCs ticking



A single-chip, real-time clock/calendar, MSM5832, supplies addressable 4-bit I/O data for seconds, minutes, hours, day, date, month and year. Data access is controlled by a 4-bit address bus and chip-select, read, write and hold inputs. The CMOS circuit contains an on-chip 32.768 kHz, crystal-controlled oscillator. A separate register identifies leap years and assures continued accurate operation. The user has a choice of 12 or 24-h timekeeping format. Only a single 5-V supply is required. Power dissipation is less than 2.5 mW. In standby mode, no more than 90 μW is consumed.

OKI Semiconductor, 1333 Lawrence Expwy., Suite 401, Santa Clara, CA 95051. (408) 984-4840. $4.80 (OEM qty).

CIRCLE NO. 359



More linear firsts from TI . . .

RS422 drivers/receivers. For balanced multipoint communication.

Introducing four new interface ICs. Two quad drivers. Two quad receivers. The first interface devices to be designed specifically for balanced multipoint data bus transmission, *and* meet EIA-RS422 standard.

All of these devices feature broad positive and negative common mode range, operate from a single 5-V supply, have 3-state outputs and very low power requirements.

And, all of these devices are pin-compatible with popular RS422 devices second-sourced by TI, including AM26LS31/32A and MC3487/86.

Up to 32 driver/receiver pairs on a common bus. Another first. A significant innovation that provides an interface for balanced transmission of serial binary information between a host computer and various types of peripheral equipment. Like an input terminal. Or a printer. At data rates up to 10M bits-per-second. Over distances as great as 4 thousand feet.

Significant features of SN75172/SN75174 drivers include high output impedance in the third state, over +12 to −7 volts common mode range with power on or off and up to 60 mA output drive capability.

Contention protection, for the case where two or more drivers are simultaneously enabled, is provided by positive and negative current limiting and thermal shutdown circuitry. Maximum standby power is a low 53 mW per channel.

Receiver circuits SN75173/SN75175, which meet RS423 as well as RS422, feature +/−200 mV input sensitivity over a common mode range of +12 to −12 V. There's also 50 mV of hysteresis for increased noise immunity and 12 K ohms minimum input impedance.

These unique characteristics make the driver/receiver pairs ideally suited for party line applications in noisy environments.

Operating from 0 to 70°C, all four new devices are offered in a 16-pin plastic or ceramic DIP.

The 100-piece price for drivers SN75172/SN75174 in the plastic package is $3.02*. For receivers SN75173/75175, $2.23*.

Samples are available now at your nearest authorized TI distributor or local field sales office. For more detailed information, send for our free brochure. Write to Texas Instruments Incorporated, P.O. Box 225012, M/S 308, Dallas, Texas 75265.

Fifty Years of Innovation

TEXAS INSTRUMENTS
INCORPORATED

CIRCLE NO. 129

*U.S. prices, subject to change without notice.

© 1980 Texas Instruments Incorporated

82165

Static RAM stores 8-k for μP systems

An 8-k static RAM, 8118, stores data for microprocessor systems. The device is organized as 1024 × 8 bits and is pin-compatible with the 2708 EPROM. A choice of 300 or 500-ns maximum access times is offered. The device uses common I/O pins for connection to a data bus. In a low-power disabled mode, power dissipation is less than 60 mW. Enabled power use is less than 270 mW. All inputs and outputs are TTL compatible. A single 5-V supply is required.

GTE Microcircuits, 2000 W. 14th St., Tempe, AZ 85281. (602) 968-4431. $31.20 (300 ns); $30.00 (500 ns) (100 qty); stock.

CIRCLE NO. 439

Dear Ma:

Racal-Vadic's new direct-connect 1200 bps half duplex modem card fits inside data terminals.

Racal-Vadic has come to the aid of the OEM with a 1200 bps half duplex modem small enough to fit inside of most data terminals.

It's very compact. Just a single PC board measuring 5 inches by 8.35 inches. That's a miserly 42 square inches of space.

The VS1200P is registered for direct connect. It comes with a cable that plugs right into your new voice or data jack, which simplifies installation. And this modem card is easily interfaced to the terminal via a 20 pin ribbon connector.

It's fully compatible with your 202C & S modems. Only better; offering much more in performance, flexibility and test capability.

There are major technical improvements, too. Unique digital design techniques insure small size, high stability and minimum power consumption. Plus TTL/CMOS logic to eliminate costly EIA level converters.

The price is right for the terminal manufacturer. Just $200 in quantities of 100.

Better write or phone Racal-Vadic for complete details on this and other OEM modems.

Racal-Vadic

222 Caspian Drive, Sunnyvale, CA 94086
Tel: (408) 744-0810 • TWX: 910-339-9297

RACAL
The Electronics Group

Racal-Vadic Regional Offices:
West (408) 744-1727 • East (301) 459-7430 • Central (312) 296-8018 • Northeast (617) 245-8790 • Southwest: (817) 277-2246

CIRCLE NO. 134

8-k UV EPROM assists prototype designs

A high-speed UV EPROM, MM2758, stores 8 kbits of data for pattern experimentation and prototype design. The device is organized as 1024 × 8 bits and offers a typical access time of 450 ns. Under normal operating conditions, power consumption is 525 mW. In standby mode, power needs drop to only 132 mW. Inputs and outputs are TTL compatible during read and program modes. Outputs are three-state. MM2758 is compatible with Intel's 2758. The memory comes in a 24-pin DIP.

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. $10.15 (100 qty); stock.

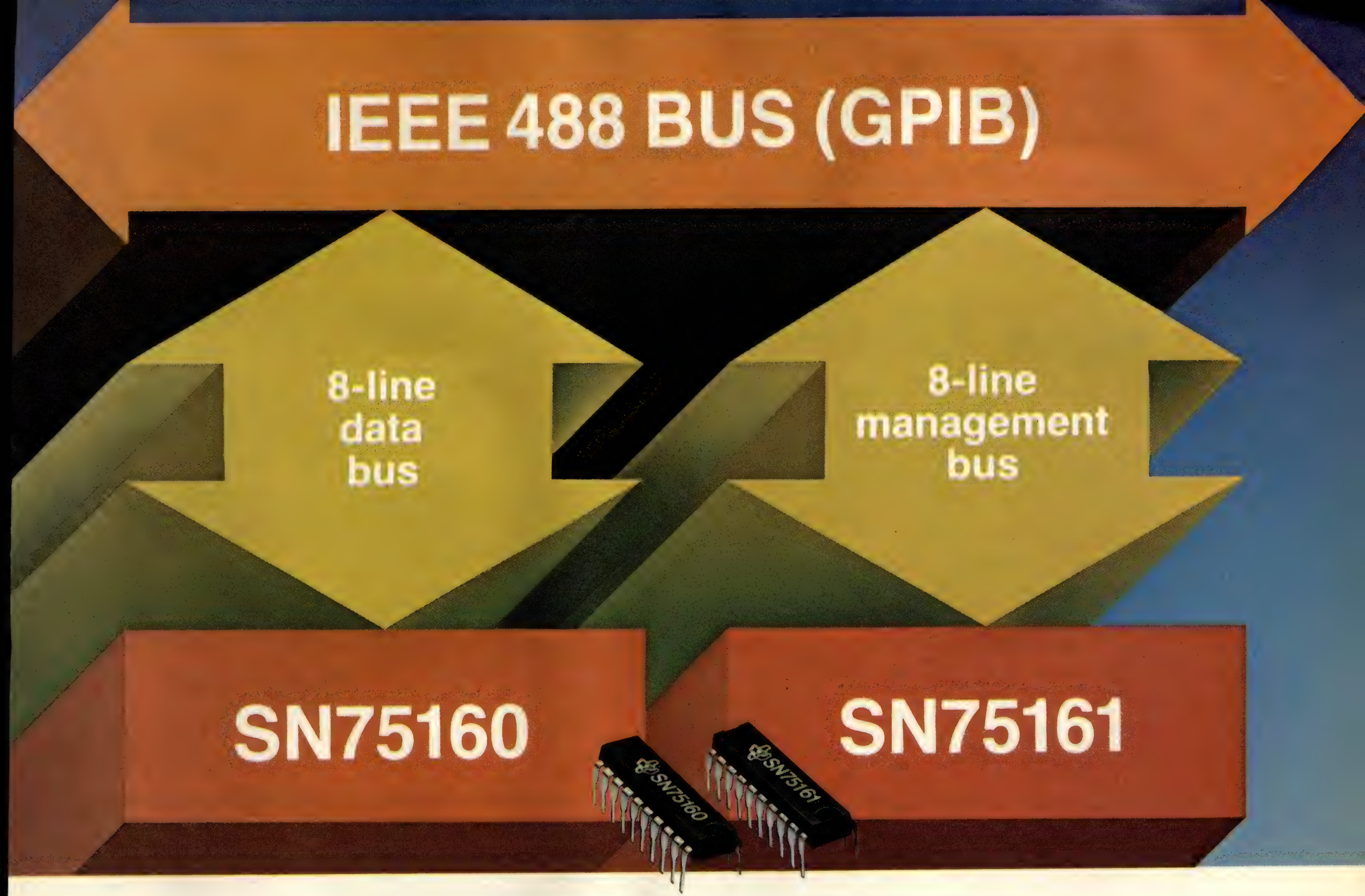
CIRCLE NO. 440

4-k static RAMs boost speed for military user

Two 4-k static RAMs, M2114A and M2147H, boost speed and lower power consumption for users of these military-rated parts. Both devices meet Class B requirements of MIL-STD-883B and are specified for operation from −55 to +125 C. The M2114A is a speed and power upgrade of the industry-standard M2114. The device, organized as 1-k × 4-bits, consumes only 50 to 70 mA and offers access speeds of 150 to 250 ns. No clocks or refreshing circuitry is needed. Data are read out nondestructively at the same polarity as entered data. All I/O buses are TTL compatible. A single 5-V supply is needed. The M2147H, a faster version of the M2147, uses HMOS II technology. The part has a power-down feature to reduce consumption.

Intel, 3065 Bowers Ave., Santa Clara, CA 95051. (408) 987-5090. $30 to $102.80 (100 qty).

CIRCLE NO. 471



Reduce power and board space 40%. TI's GPIB octal transceivers.

Two octal, bidirectional bus transceivers that meet the IEEE 488 General Purpose Interface Bus (GPIB) Standard.

The SN75160 data bus transceiver and SN75161 management bus transceiver contain all the circuitry required, yet consume only 95 mW per channel. That's 40% less power than conventional quad circuits.

And you can reduce pc board space required for IEEE 488 applications by replacing 4 quads and associated external logic with 2 octals.

But that's not all. Bus terminating network as specified by IEEE 488 is provided on all driver outputs. It also provides a *high* impedance even with power off.

In addition, the output structure of the SN75160 data bus transceiver makes it a versatile device suitable for many other octal transceiver applications.

Transceiver features

The SN75160 and SN75161 feature built-in bus terminating resistors on driver outputs, high impedance to bus during power down, enable control selection of 3-state or open-collector driver output (SN75160 only), 3-state outputs on receiver, hysteresis on receiver inputs, high impedance PNP inputs, 20-pin dual-in line package.

The management bus transceiver SN75161 has several additional features: internal logic for proper direction of control signals on management bus, properly assigned output structures (active or passive) which eliminate necessity for external control, no external logic requirements.

Powerful combination

The SN75160 and SN75161 combine to yield a complete IEEE Standard 488 16-line bus interface system. A system that allows asynchronous communication between satellite equipment on a bi-directional 8-line data bus. The 8-line management bus provides handshake protocol to assure interlocked communication between talker and listener.

In 100 pieces, the cost for SN75160 is $3.90.* The 100 piece price for SN75161, $4.32.*

Send for data sheets

For fast delivery call your nearest authorized TI distributor.
For data sheet information write: Texas Instruments Incorporated,
P.O.Box 225012, M/S 308,
Dallas, Texas 75265.

Fifty Years of Innovation

TEXAS INSTRUMENTS
INCORPORATED

CIRCLE NO. 133

*U.S. prices, subject to change without notice

© 1980 Texas Instruments Incorporated

82147A

Motorola's unique multi-million dollar facility in Joplin . . .

NCC
Booth
2234

a meaningful new factor in your CRT Display decisions.

Make; buy; where to buy? If you are involved with CRT Display decisions, the new Motorola facility in Joplin, MO, is of vital interest to you. It houses the most inventive and exacting production and in-line testing equipment ever designed to achieve the ultimate in consistent quality conformance for CRT display systems.

Only Motorola can offer phase to phase quality control and verification throughout the total CRT Display manufacturing process.

Beginning with basic components manufacturing, the Joplin plant is equipped with the latest in programmed sequencing and automatic insertion. New production line techniques keep handling to a minimum as circuit panels move through assembly and self-soldering stations. Verified at every stage, the panels must then pass testing on Motorola's futuristic Video Display Analyzers. No faulty focus or resolution; no blemish; no linear or geometric flaw can escape detection. Finally, samples of every production run are subjected to long term extreme environmental testing.

The bottom line is consistent top quality and reliability at the right price. The Joplin plant represents a new state of the art in engineering and manufacturing fine CRT Displays. No terminal manufacturer could profitably match Motorola's productivity and the overall quality of its end product.

Motorola displays the character of your business.

MOTOROLA
Display Systems
1155 Harvester Road West Chicago, IL 60185
312/231-4400

CIRCLE NO. 157

Rugged packages that plug in much like audio cassettes offer nonvolatile storage capacities of 64 and 256 kbits.

Bubbles pack storage, speed in cassettes

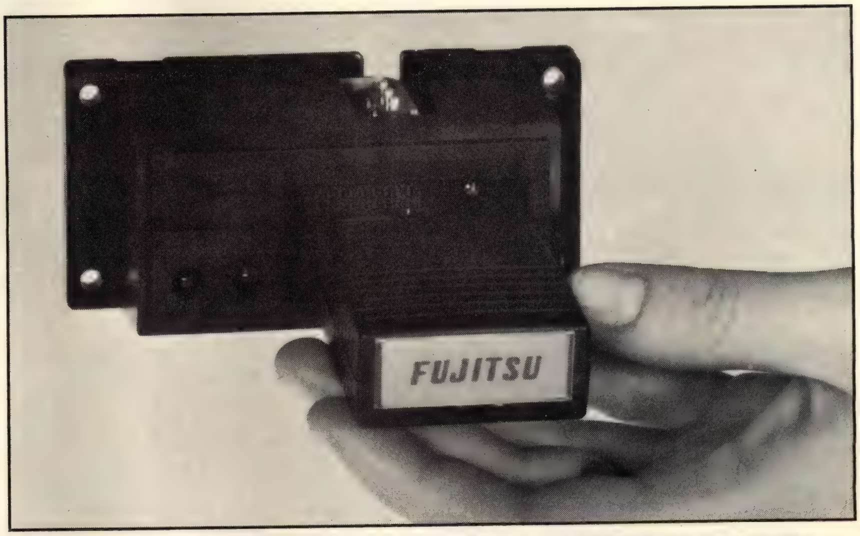
A bubble-memory cassette system offering 64 kbits of nonvolatile but alterable serial storage and 0.74-second worst-case access time will be joined by a major/minor-loop bubble cassette with a quarter-Mbit capacity and 6-ms average access. Both will be unveiled at Electro.

Based on a serial-loop bubble-memory device housed in a removable cassette cartridge (the FBM31CA), the first system contains a cassette holder (the FBM-U001), which holds the basic drive components, and a controller, the FBC308C1A, which provides the interface to a host system. Eight holders can be controlled by one FBC308C1A.

The cassette-cartridge bubble memory uses a serial-loop architecture, has a data capacity of 65,536 bits and a worst-case access time of 740 ms when operated at a 100-kHz field frequency. Measuring just 20 × 60 × 45 mm (0.787 × 2.362 × 1.772 in.), the bubble cassette interfaces to the holder via a 24-pin interface.

Total power requirements for the 64-kbit device add up to about 500 mW and increase to about 700 mW for the FBM43CA.

Both cassettes transfer data at 100 kbits/s and operate from 0 to 55 C. Both weigh just 50 grams.



The FBM31CA 64-kilobit bubble-memory cassette plugs into its holder much like an audio cassette. Fields up to 50 Oe have no effect on the stored data.

The cassettes mate to the holder module, which is intended for panel mounting, much like a front-load audio cassette deck. Measuring 114 × 52 × 53.5 mm (4.448 × 2.037 × 2.106 in.), the holder requires four supplies to provide power to the FBM31CA cassette. A holder with different electronics is required for the FBM43CA cassette. Supplies required are +5 V at 0.4 A, +12 V at 0.25 A, +17 V at 0.1 A, and −5 V at 0.1 A, all ±5%.

Controlling the cassettes and holders is the FBC308C1A card, which is dedicated for the FBM31CA cassette; another version of the controller is required for the FBM43CA. Built on a 230 × 160-mm (9.055 × 6.299-in.) card, the controller can handle data from up to eight holder units, and deliver byte-wide data to the host system. The controller, which operates over 0 to 55 C, requires three supplies: 5 V at 1.5 A and ±12 V at 0.25 and 0.1 A, respectively.

Prices for the bubble-cassette-system components start at $117.50 for the FBM31CA cassette, $212.50 for the FBM-U001 cassette holder and $331.25 for the controller, all for one to nine sample quantities. Prices for the FBM43CA have not yet been established. Delivery: eight weeks.

Fujitsu America, Component Sales, 910 Sherwood Drive—23, Lake Bluff, IL 60044. (312) 295-2610.

Electro 3107 **CIRCLE NO. 310**

Dave Bursky, Semiconductors Editor

Tape carts extend on-line storage to 512 kbytes

Dualtape-58, dual cassette tape cartridge units, increase removable mass storage capability to 512 kbytes. The on-line, random-access storage device is supported as a standard device under most DEC operating system, including RSTS-E, RSX-11M and RT-11. RT-11 allows the unit to be used as a system device, making it a complete replacement for disk. Through an RS-232 or RS-423 asynchronous port, Dualtape-58 interfaces to any computer at rates from 150 to 38,400 baud. An intelligent controller within Dualtape-58 allows random access of any of the 1024 blocks of storage as though they were on disk. A high-speed search mode gives an average access time of 9.3 s to any block. The cartridge unit is offered in rack-mount or tabletop styles.

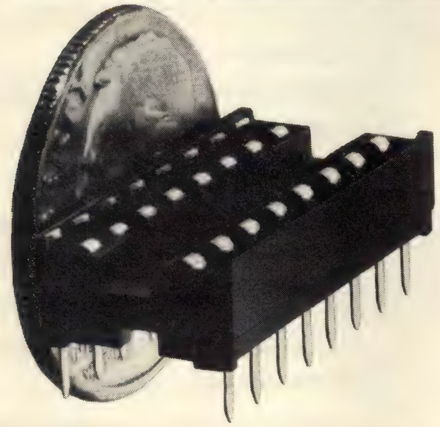
General Digital, 3322 S. Memorial Pkwy., Huntsville, AL 35801. (205) 883-1700. $1200.

CIRCLE NO. 362

We listened. Here it is!

Easy Insertion ...High Retention

"Lo-Rise™" DIP Production Socket



Now...all the features you asked for in a production socket from a proven leader in test/burn-in sockets.

We've put two years of design effort into our new lo-rise production socket...and we're proud of it! The 802 Socket has a low average insertion force of only 39.91 grams per pin. High extraction force of 72.90 grams that resists shock and vibration. Widest entry area ever. Dual side wiping contacts. Easy-to-clean open frame. Orientation and air circulation groove. Protective sealed bottom that eliminates solder wicking. End-to-end and side-to-side stackability. Available in 8 to 40 pinouts. Material meets U.L. 94 V-O Spec. Competitively priced, it's a total package of recognized Welcon socket reliability.

We deliver too. Quickly. Dependably. We make it easy for you to find the right person with the right socket information. We're small enough to be customer oriented, with service people willing to discuss your special socket requirements. Give us a call, and discover just how responsive a company can be. For full details, call 219/287-5941.

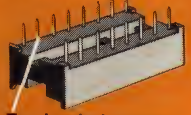
Welcon™

Wells Electronics Inc., 1701 So. Main, So. Bend, IN 46613 U.S.A.

DUAL, SIDE WIPING CONTACTS

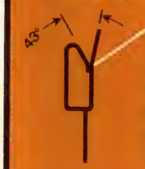
Low contact resistance. High retention force. Will not damage I/C lead.

CLOSED BOTTOM



Top loaded contact. Press-fit into housing prevents solder wicking.

WIDE TARGET AREA



Dual-sided contacts, ramped in. Handles splayed leads or off-center insertion.

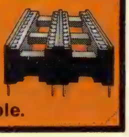
ANTI-OVERSTRESS BARRIER

Protects contact from overzealous probing or clumsy insertion.

OPEN FRAME CONSTRUCTION

Allows for easy P.C. board cleaning and trace observation or repair.

END AND SIDE STACKABLE



On .100″ centers. Provides for high density packaging. Also machine insertable.

CIRCLE NO. 158

Card reader operates on-line in IBM format

A 300 card/minute, 80-column card reader, CR300/88, contains IBM bisynchronous communications capability for use with any computer supporting IBM 3780, 3741, 2780 or 2770 terminals. The reader works on-line or over telephone lines to many IBM installations, as well as systems that can communicate with IBM computers, such as the Mohawk Series 21. A patented feed mechanism assures minimum card jams and reduction of problems caused by worn or damaged cards. Fiber optics, synchronized logic and error checking features provide reliable reading and transmission. The unit occupies only 2-3/4 ft² of tabletop space.

Cardamation, P.O. Box 746, Frazer, PA 19355. (215) 647-8260. $4975.

CIRCLE NO. 363

Controller directs plotter in time-share operation

A plotter controller, Model PTC-6-1, operates digital plotters remotely from a host computer via an interactive timeshare terminal. The controller uses a microprocessor to provide such features as local character generation at all angles, automatic detection and correction of data transmission errors and firmware generation of incremental commands from vector data. PTC-6-1 can also operate as an on-line interface to computers having communications capabilities. The unit accepts data from an RS-232C data source or a 20-mA loop-current source. It operates at 110 to 9600 baud and offers 172 firmware-generated ASCII characters. Additional features include complete circle and rectangle generation, a self-test function, aspect ratio, slanted characters and rear-panel switches for selection of up to 18 plotting speeds.

Houston Instrument, One Houston Sq., Austin, TX 78753. (512) 837-2820. $1995.

CIRCLE NO. 441

Tape unit backs up hard disk storage

A magnetic tape unit, using a self-threading tape cassette, supplies backup storage capacity for non-removable hard-disk drives. The IU 1650 stores up to 56 Mbytes (unformatted) at 6400 bits/in. on nine tracks. Transfer rate is 250 kbits/s. Read/write speed is 40 in./s.

Interdyne, 14761 Califa St., Van Nuys, CA 91411. (213) 787-6800.

CIRCLE NO. 442

Terminal matches Teletype/ASCII formats

Telex 310, an ASCII/Teletype-compatible terminal, satisfies the needs of interactive terminal users requiring communications at speeds to 9600 bits/s. The 310 has a high-resolution 15-in. display, 7 × 11 dot-matrix characters and a 128-character detachable keyboard with numeric keypad. The terminal displays 24 lines of information, with a 25th line available for diagnostics or operator prompting. Features include full keyboard cursor movement, video and blinking.

Telex, 6422 E. 41st St., Tulsa, OK 74135. (918) 627-1111. $900 (100 qty); 4 wks.

CIRCLE NO. 443

IF YOUR BUSINESS DEPENDS ON THE RIGHT CONNECTIONS, WE'LL MAKE THEM FOR YOU.

Model SD12. For Struthers-Dunn 219 Frame Relay and Proximity Switches.

Miniature MR Series. No retaining ring. Pre-wire it.

CM Series. Square base. Chassis mount. Quick-connector solder terminals.

Model QC11 Top wired. Closed back.

Model RB08. Top wired. Closed back.

Model RB11. Top wired. Closed back.

Miniature MR Series. For automatic wiring equipment.

Telephone Relay Socket Produced for a major elevator manufacturer. Body of Noryl thermoplastic. Contacts of tin-plated Berylium copper.

Promptly. That's right, Custom Connector will design and produce any relay socket you need. With more precision and less time than anyone else. Because we've got the years of proven design experience and manufacturing skill that it takes to do it.

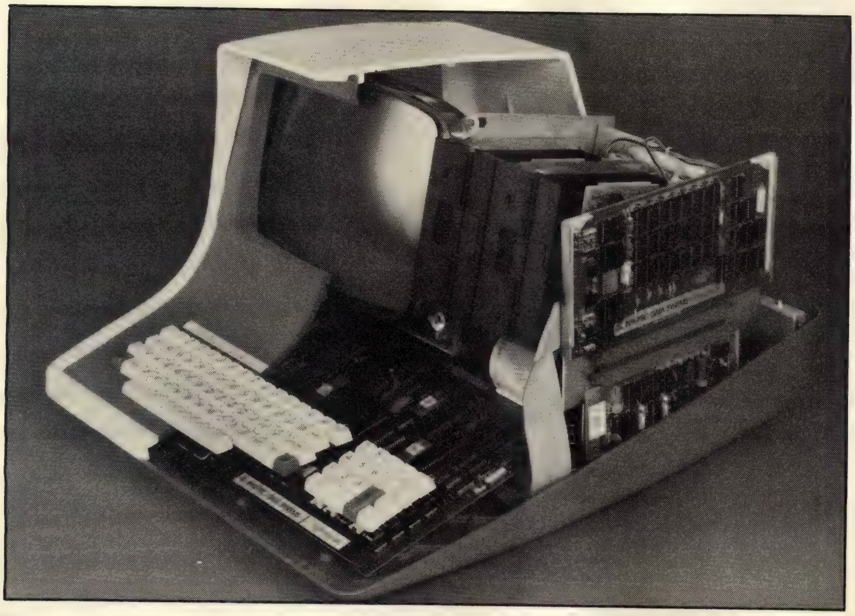
We may have already made what you need. If we haven't, just send us your specs. We'll send you our quote on engineering and producing exactly what you're looking for. You can rely on us.

Custom Connector Corporation

WRITE NOW FOR OUR FREE BROCHURE.
1738 East 30th Street
Cleveland, OH 44114 (216) 241-1679

CIRCLE NO. 159

Emulator simulates four CRT terminals



This emulator from Intertec can simulate the terminal control codes of four popular CRT terminals.

An emulator of four popular CRT terminals joins two other products slated to be unveiled by Intertec at NCC: a "super brain" and a Winchester-type disk drive with 20 Mbytes of storage capacity.

To try Lear Siegler's ADM-3A, DEC's VT-52, Hazeltine's 1500 and Soroc's IQ-120 without buying them, check the Emulator, which, for $885, emulates the terminal-control codes of all four while throwing its own personality into the job. This includes an auxiliary RS-232C printer port, a numeric keyboard, a 12-in. nonglare screen and a terminal-status line that the user can display as needed.

The Emulator works over a range of 50 to 9600 bits/s and displays 24 lines by 80 columns. It's easy to maintain, too, since it's made up of only three removable modules.

If the Emulator doesn't sound smart enough, there is the Intertec Superbrain QD. An iteration of the company's original Superbrain—which features twin Z80 processors—the QD steps up to 64 kbytes of RAM and double-sided double-density drives to yield a total of 715,000 bytes of formatted data. And it costs just $3995. But hook up the QD to Intertec's new 20-Mbyte Winchester-type drive, the CompuStar 20, and the combination is even more powerful.

With a multiplex adapter, the CompuStar can accommodate up to 32 independent users, each using a processor and RAM at his workstation. As a result, multiple tasking or programming can proceed, with no user ever having to wait for another user to go ahead him.

The basic system starts at $5000; each adapter adds $1500 to the price. Superbrain Juniors sell for less than $2000 a user.

Intertec Data Systems, 2300 Broad River Rd., Columbia, SC 29210. (803) 798-9100.

NCC:2240 **CIRCLE NO. 486**

HAYDEN TAPES
ARE NOT
SOMEWHERE
OVER THE
RAINBOW...

SLOW LIST/STOP LIST (Gilder) Start, stop, and control the speed of your program with Apple II's game paddles. Control the speed at which the disk catalog appears and terminate CATALOG operation in the middle. The program can be enabled and disabled under software control. **#03904, Apple II, $10.95**

REVIVE (Gilder) When a program is accidentally erased, REVIVE searches through memory and finds the information that enables it to restore the pointers that have been changed. Can be loaded at any time, even after you have accidentally erased the program. **#03604, Apple II, $19.95.**

SONGS IN THE KEY OF APPLE (Lopatin). Allows you to see and hear your favorite tunes, pre-programmed tunes, or music you create (up to 200 notes, including rests per musical piece). Multi-color graphics accompany all music. **#03304, Apple II, $10.95.**

APPLESOFT UTILITY PROGRAMS (Gilder) Contains 9 subroutines, among them 3 different statement formatters: REM, PRINT, and Pokewriter. Other subroutines included are: calculating the decimal address of your machine language program, checking for illegal branches and indicating where one exists, joining two or more programs together, etc. **#03504, Apple II, $29.95.**

**They're Down To
Earth And At Your
Local Computer Store!**

Hayden Book Company, Inc.
50 Essex Street, Rochelle Park, NJ 07662

Amphenol® modular jacks. Four kinds for all kinds of connections to electronic key sets, data sets, modems, and more.

If you're plugging equipment into the telephone network, connect Amphenol 285 Series modular jacks to your equipment. You'll get standard interfacing with telephone double-ended modular plug/cords.

Your choice of four jack configurations: 6-position. 8-position non-keyed. 8-position keyed. 8-position series.

Amphenol modular jacks can be mounted to PC boards or panel cutouts, either vertically or horizontally. We also offer the widest choice of terminations: Stripped ends. Spade lugs. Ring lugs. Taper pins. And all wire leads are color-coded.

For complete information, technical data, dimensions and prices, contact your nearest Amphenol North America sales office or distributor.

See Us at Electro '80 Space 2544-2550

BUNKER RAMO **AMPHENOL NORTH AMERICA**
A Division of Bunker Ramo Corporation

Amphenol North America Division Headquarters: Oak Brook, Illinois 60521

Sales Offices: Atlanta (404) 394-6298 • Boston (617) 475-7055 • Chicago (312) 986-2330 • Dallas (214) 235-8318 • Dayton (513) 294-0461 Denver (303) 752-4114 • Greensboro (919) 292-9273 • Houston (713) 444-4096 • Indianapolis (317) 842-3245 • Kansas City (816) 737-3937 Knoxville (615) 690-6765 • Los Angeles (213) 649-5015 • Minneapolis (612) 835-4595 • New York (516) 364-2270 • Orlando (305) 647-5504 Philadelphia (215) 732-1427 • Phoenix (602) 265-3227 • St. Louis (314) 569-2277 • San Diego (714) 272-5451 • San Francisco (408) 732-8990 Seattle (206) 455-2525 • Syracuse (315) 455-5786 • Washington, DC (703) 524-8700
Canada: Montreal (514) 482-5520 • Toronto (416) 291-4401 • Vancouver (604) 278-7636 • **International:** Oak Brook, Illinois TELEX 206-054

CIRCLE NO. 160

At Boeing
forty dedicated systems
Tektronix 8001s

The Microprocessor Design Support Center (MDSC) is Boeing's innovative answer to large scale microprocessor development. Tektronix makes it possible.

Boeing now supports over 120 engineers working on 35 projects.

Before the creation of the MDSC, Boeing used a variety of different vendors' stand-alone development systems. Each one supported only three engineers at a time, and more than one system was often needed for a single project.

Now, software is developed on a DEC PDP 11/70® computer and transferred to six 8001 Microprocessor Development Labs for in-circuit emulation, debugging, and prototype integration.

By using one multi-user host computer with six distributed 8001s, Boeing is able to more efficiently support 120 engineers. With 8001s costing half as much as stand-alone development systems.

couldn't do what six are doing.

FOR TECHNICAL DATA CIRCLE NUMBER
FOR DEMONSTRATION CIRCLE NUMBER 21

Development isn't limited by dedicated, single-vendor systems.

The 8001 supports every microprocessor Boeing uses, so, they're free to choose the right microprocessor for the job. And whether it's the Texas Instruments TMS9900, Zilog Z80A, Intel 8048, Motorola 6800, RCA 1802, or 14 others — the 8001 emulates it. Tek's multi-vendor support doesn't lock Boeing into one vendor's family of microprocessors.

Engineers get on board much faster.

When every engineer uses the same equipment and the same operating system for every project, it translates into a faster learning curve. And a more efficient, flexible team. For Boeing — or for you.

The world over, Tektronix supports your team with our team, assisting you with everything from development system configuration planning to training to service. Whether your development plans include our 8001 MDL, or our stand-alone 8002A MDL, we'll back you with quality — every step of the way. For a closer look at Boeing's innovative use of the 8001, please call your local Tektronix Field Office or write to us for our Boeing Application Note.

U.S.A.
Tektronix, Inc.
P.O. Box 1700
Beaverton, OR 97075
Phone: 503/644-0161
Telex: 910-467-8708
Cable: TEKTRONIX

Africa, Europe Middle East
Tektronix Int'l, Inc.
European Marketing Center
Postbox 827
1180 AV Amstelveen
The Netherlands
Telex: 18312

Asia, Australia, Canada, Central & South America, Japan
Tektronix, Inc.
America's/Pacific
P.O. Box 500
Beaverton, OR 97077
Telex: 910-467-8708
Cable: TEKTRONIX

Tektronix®
COMMITTED TO EXCELLENCE

FOR IMMEDIATE ACTION DIAL OUR TOLL FREE AUTOMATIC ANSWERING SERVICE 1-800-547-1512

Copyright © 1980. Tektronix, Inc. All rights reserved. 871

A low cost storage scope with autotrigger...another better product from Kikusui.

We call it the 5516ST. Rugged and portable, this dual-trace 10MHz scope will do everything that Tek's T912A will do... and a lot more. It offers a combination of features that are unequalled by any other instrument in its price range. Features such as an *enhance* capability that lets you vary the writing speed from 20 to 40 usecs/cm; a *hold* button that freezes the waveform on the CRT for up to one hour; and a patented *autoerase* that lets you set any predetermined hold time from one to thirty seconds. After the preset time the waveform is automatically erased and the sweep circuit is reset. The 5516ST also has an ADD mode, an X-Y mode and four trigger modes.

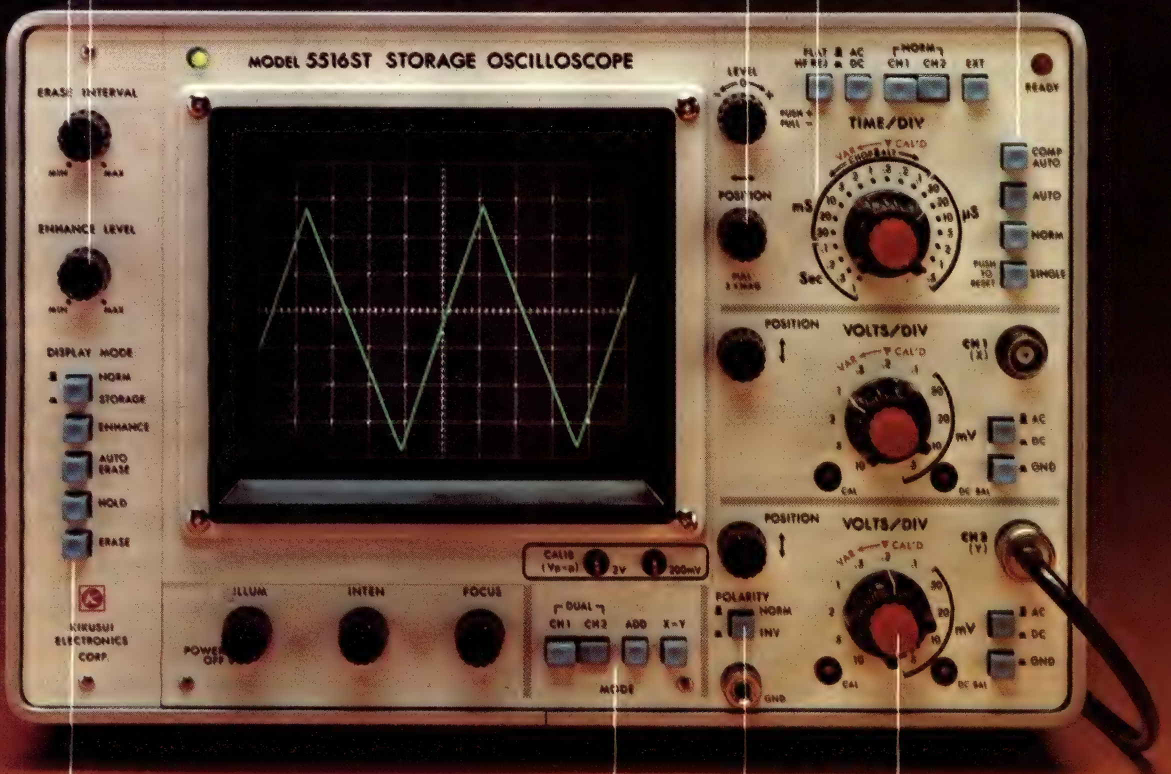
But there's a lot more to this KIK-scope than performance and specifications. For one thing, your KIK-scope is completely modular. All components are on plug-in boards. In the event of trouble, just send us the faulty board and we'll send you a replacement by return mail. This swap-out program assures fast maintenance turn-around and minimum down-time. Then there's our 2-year warranty (CRT 1-year). That's twice as long as the warranty from most manufacturers and a reflection of the confidence we have in the quality components and workmanship that go into all KIK-scopes.

And, just to give you a little added assurance, your KIK-scope comes with a 30-day "satisfaction-or-your-money-back" insurance policy. We wouldn't make an offer like this if we weren't sure we had a better scope.

In addition to the Model 5516ST, there are nine other KIK-scopes in the line from 10MHz to 50MHz. They're described in our new catalogs along with our lab power supplies and other instruments.

Kikusui International Corporation
17121 South Central Ave., Suite #2M
Carson, California 90746
(213) 638-6107 • TWX 910-346-7648

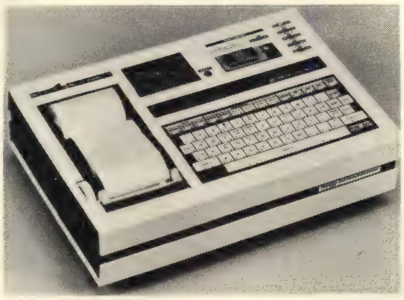
Kikusui
INTERNATIONAL CORP.
A subsidiary of
KIKUSUI ELECTRONICS CORP. JAPAN


Erase Interval Control 1 to 30 secs
Writing Speed Control 20 to 40 μs/cm
5X Horizontal Magnification
Sweep Time 0.5 μs/div to 1s/div in 20 Steps
4 Trigger Modes: Complete Auto (p-p), Auto, Norm, Single
MODEL 5516ST STORAGE OSCILLOSCOPE
5 Storage Controls Norm, Store, Enhance, Auto Erase, Erase, Hold
4 Vertical Modes: Channel 1, 2, Add, X-Y
Channel 2 Polarity
Sensitivity: 5mV/div to 10V/div in 11 Steps

CIRCLE NO. 162

See us at Electro Booth 412.

Portable computer tester performs on-site checks



A portable, microcomputer-based system, Microcommunicator Model 177, performs rapid on-site diagnostics of computer systems. The self-contained unit weighs only 8.5 lb and fits easily into an attache case. Fast analysis can be obtained of both hardware and software problems. The tester contains a full ASCII keyboard, a 16-character display with a four-line buffer, a 32-kbyte ANSI minicassette drive, a 32-column hard-copy printer, a ROM writer and switch-selectable communications features. Applications include use as a multifunction I/O console.

Digital Datacom, 17951 Skypark Circle, Suite K, Irvine, CA 92714. (714) 549-8943. $1995; 4 wks.

CIRCLE NO. 444

One module programs 200 different PROMs

A single module, called UniPak, allows System 19 users to program more than 200 different MOS and bipolar PROMs from a variety of different sources. A user simply keys a four-digit code for a particular PROM into the System 19's hexadecimal keyboard. The UniPak software assembles the programming algorithm and selects the correct socket for the 16 to 28-pin PROM. Use of UniPak allows increased freedom in the design of systems using PROMs.

Data I/O, P.O. Box 308, Issaquah, WA 98027. (206) 455-3990. $1800; 4 to 6 wks.

CIRCLE NO. 445

Bidirectional printer works at 100 char/s

A bidirectional printer, the Model 4520, gives printing speeds of 100 characters/s. Noise level is less than 60 dBa.

Facit, 66 Field Point Rd., Greenwich, CT 06830. (203) 622-9150. Under $1000.

CIRCLE NO. 446

Power Products won't keep you waiting.

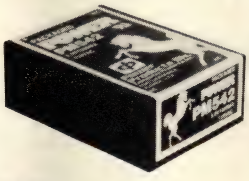
We ship all popular AC-DC power supplies within three days ARO.

±15V @ 200mA
• .02% Regulation
• 0.5mV RMS Ripple/Noise
• UL Recognized
• Two-year warranty $45*

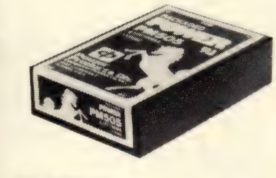
Power Products' exclusive Blue Streak Delivery System ensures quick shipment of prototype (1-3 piece) quantities. So you can power-up a new design sooner.

Choose from more than 50 standard supplies, like the popular models shown here. We stock single, dual, and triple output power supplies, featuring all popular outputs from 3.6 to 28 volts. Why wait? We can put the power in your hands in just three days from now!

Call or write for our free catalog before you're pressed for power. Or, if you need it now, order today. And ask for Blue Streak Service.



PM542
5.0V @ 1A.Regulation: ±0.02% Line/±0.04% load. 1.0mV RMS Ripple/Noise. Built-in overvoltage protection. Powers all popular digital logic. $45.00*



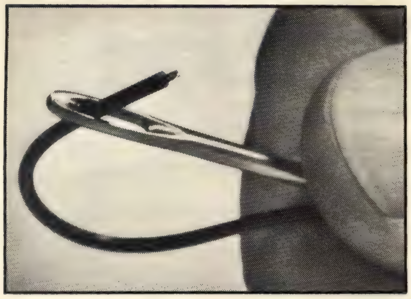
PM505
±15V @ 100mA. Regulation: ±0.02% Line/±0.02% load. 0.5mV RMS Ripple/Noise. 50 megohms input isolation. Ideal for powering op-amps and precision instrumentation. $33.00*

PM396
±15V @ 500mA. Regulation: ±0.05% Line/±0.05% load. 1.0mV Ripple/Noise. Chassis-mount model for use with linear IC and discrete analog circuits. $78.00*
(*OEM quantity price)

The Packaged Power Professionals
Power Products
Division of Computer Products, Inc.
1400 N.W. 70 ST./FORT LAUDERDALE, FLA. 33309 • (305) 974-2442/TWX 510-956-3098

CIRCLE NO. 163

Silica-core cable bends without breaking



Ultrathin silica-core fiber-optic cable gets extra flexibility and ruggedness from a hard polymer cladding developed by DuPont. As a result, the Pifax S-120 Type 40C fiber, which has a 200-μm silica core, and a 1250-μm outer-jacket diameter, features a bend radius down to 1.5 mm.

Silica-core fiber has always had an advantage over plastic-core fibers because of its lower loss. Up to now, however, small-diameter silica fibers have frequently turned out to be brittle. That disadvantage disappears in the DuPont fiber.

The Pifax S-120 Type 40C offers fiber attenuations of less than 40 dB/km at 820 nm (35 dB/km at 790 nm) and a numerical aperture of 0.42. Comparable Type P-140 plastic-core cable has an attenuation of 350 dB/km at 790 nm. But better yet, the protective cladding brings forth a flexibility that increases the silica-core fiber's range of applications.

Prices vary according to quantity from $1.50 to $1.15 per meter. Delivery is from stock to six weeks.

DuPont Co., Rm. 37925PA, Wilmington, DE 19898. Julius Uradnischeck (302) 774-2320.

CIRCLE NO. 302

Converter links asynch terminal to sync modem

Asynchronous terminals can interface with synchronous modems through the Avanti 400 converter. The unit operates regardless of character format. Equipped with its own power supply, the converter remains totally independent of the modem. A front-panel switch facilitates data rate selection from 150 to 39,600 bits/s. Installation is easy—only two RS-232C cable connections to rear-panel connectors and an ac power cord connection.

Avanti Communications, Aquidneck Industrial Park, Newport, RI 02840. (401) 849-4660. $295.

CIRCLE NO. 428

*LOW-COST PIGTAILED EMITTER AND DETECTOR IRE 170 AND DIR 170

FEATURING:

- LED AND DETECTOR COUPLED TO FIBER AND CONNECTOR
- VISIBLE EMITTER AT 670 nm
- DETECTOR IN RANGE 350 nm TO 1150 nm
- EMITTER RISE AND FALL OF 70 ns
- DETECTOR RISE AND FALL OF 3 ns

Custom Devices Available on Special Order
For Additional Information, Contact Marketing Department

YOUR ONE SOURCE FOR F/O COMPONENTS

LASER DIODE
LABORATORIES, INC

1130 Somerset Street, New Brunswick, New Jersey 08901
Tel.: 201-249-7000 • TWX: 710-998-0597 • A Subsidiary of **VALTEC** Corporation

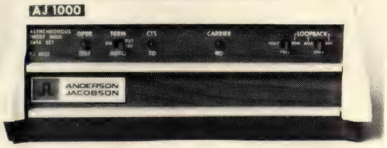
*** IRE 170 — $30.50 ea. in lots of 100**

DIR 170 — $40.00 ea. in lots of 100

CIRCLE NO. 164

COMMUNICATIONS

Modem connects computers at 28 miles



A short-haul data set, AJ 1050, uses customer-provided, twisted-pair cable to send asynchronous data up to 28 miles. The unit operates at from 0 to 9600 bits/s in half or full-duplex systems. The set links computers and terminals and is especially suited for digital communications for in-house time-share operations, multi-building companies and college and university campuses. Diagnostic capabilities allow operators to perform both local and remote tests of data sets, as well as the communications link between them.

Anderson Jacobson, 521 Charcot Ave., San Jose, CA 95131. (408) 263-8520.

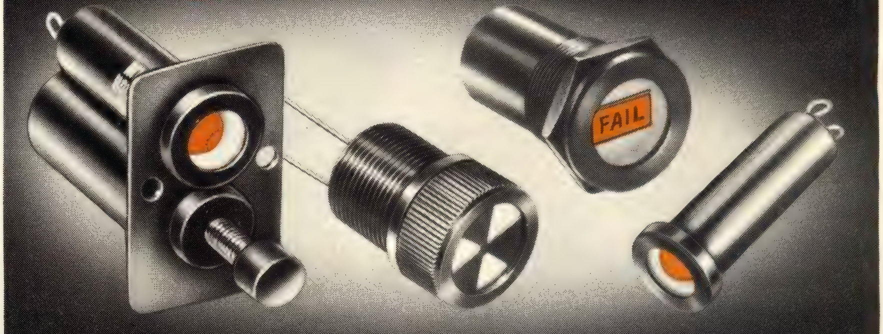
CIRCLE NO. 429

Preamplifier boosts signals in L-band

A single-stage preamplifier, A-1200-11-1, boosts signals in the 970 to 1450-MHz range. Noise figure is typically 2 dB over the range while input and output VSWR remains at less than 2:1, with or without power applied. Quadrature hybrids at both the input and output keep VSWR low. Minimum gain is 11 db. Power requirement is less than 25 mA at 15 V. Power output at the 1-dB gain compression point is 0 dBm. Another version offers slightly higher gain over the 700 to 1000-MHz range.

Sage Laboratories, 3 Huron Dr., Natick, MA 01760. (617) 653-0844.

CIRCLE NO. 430



magnetic memory

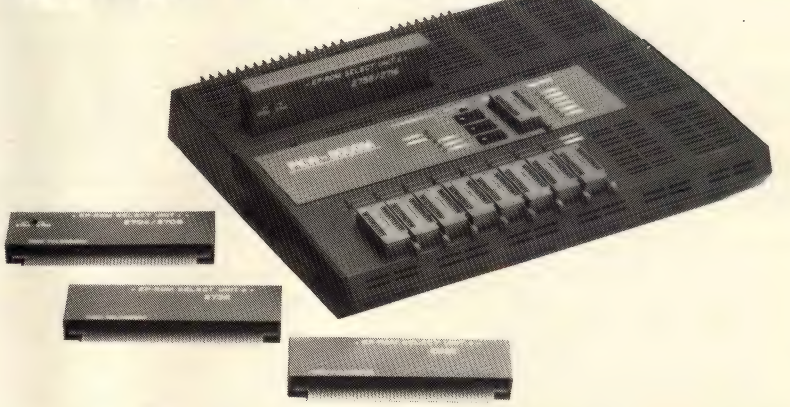
minelco's wide selection of latching indicators

Ultimate dependability in fault detection! Minelco's unique, patented magnetic latching indicators retain highly-visible fault indication, even if power fails or restores. Not subject to light or LED failures. Widest selection of ball, flag or annunicator models . . . self-restoring or manual reset . . . for industrial, computer, communication, aircraft, test equipment, etc. For prototypes call Minelco, A Talley Industries Company, 135 So. Main Street, Thomaston, CT 06787. Phone (203) 283-8261.

minelco
a TALLEY INDUSTRIES Company
Visit Minelco, Booths 3015 & 3017, Electro/80

CIRCLE NO. 173

THE GANG PROGRAMMER THAT GIVES YOU MORE FOR LESS...



The PkW-8000 handles up to eight EPROM's simultaneously without extra options utilizing built-in power supply and four standard selection units. Almost every type of EPROM can be programmed. Yet, it weighs just over ten pounds, is compact and efficiently portable. Extra automatic functions include a voltage margin check, incorrect EPROM insertion check, data bus check and a level limiter. Compare reliability, performance and low cost and you'll agree that the PKW-8000 does give you more for less.

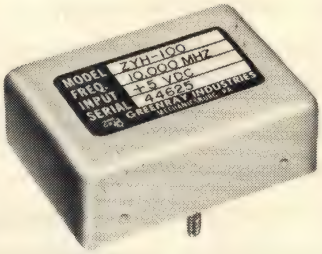
For complete information, price and delivery, write or phone.

WES-CON PRODUCTS, INC.
525 University Ave., Suite 705, Palo Alto, CA 94301, Telephone (415) 327-4051 TELEX 345549

CIRCLE NO. 174

MINIATURE FREQUENCY STANDARD

±5 × 10⁻⁸/DAY



5 CUBIC INCHES
Available 1 to 60 MHz

CALL OR WRITE

Greenray Industries, Inc.
840 West Church Rd.
Mechanicsburg, PA 17055
Phone 717-766-0223

CIRCLE NO. 175

CURRENT MONITORS

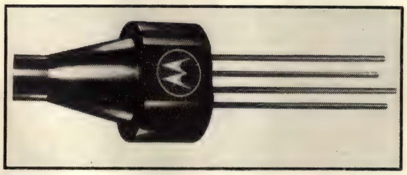
With our monitor and your oscilloscope, read fast pulsed currents (nsec to millisec) of any conductor. Prices range from $70 for standard, in-stock models. Sensitivities from 1 V/A to .01 V/A; no physical connections required; readings without ground loops; BNC standard; specials upon request.

For further information write or call: Ion Physics Company, P.O. Box 416, Burlington, Mass. 01803. Tel. 617-272-2800.

ION PHYSICS COMPANY
A DIVISION OF HIGH VOLTAGE ENGINEERING CORPORATION

CIRCLE NO. 176

Detector combines sensitivity, speed



An integrated detector preamplifier, intended by Motorola to supplement its line of ferruled fiber-optic components, combines high sensitivity with high speed for short-haul data communications. Even with its high responsivity of 30 mV/μW (with 2-μW input and a V_{cc} of +5 V), the MFOD404F will sustain transmissions at up to 10 Mbit/s.

Up to now, most fiber-optic detectors required a big tradeoff between speed and sensitivity. With the MDOD404F, the tradeoff is much smaller. Motorola's MFOD402F, for example, has a wider bandwidth than the 404—sustaining transmissions up to 30 Mbits/s—but a much lower responsivity, typically 1.5 mV/μW with a 15-V supply. The MFOD404F is somewhat slower, with 50-ns rise and fall times (compared with 20 ns for the 402).

Like other products in the fiber-optic line, the 404F is available in the AMP plastic ferrule for use with the AMP fiber-optic connector barrel. This provides precise fiber-to-fiber alignment for high coupling efficiency.

The MFOD404F is priced at about $40 in small quantities. Samples are available from stock, with production quantities scheduled to be available in the third quarter.

Motorola Semiconductor Products, P.O. Box 295, Phoenix, AZ 85062. Harry Koski (602) 244-4305.

CIRCLE NO. 306

1.4-GHz power amplifier monitors its status

A solid-state rf power amplifier, Model PA 1385-122/4800, monitors overall amplifier performance, including the status of its replaceable modules. Protection circuitry prevents amplifier damage due to output load mismatch, excessive input drive, out-of-band drive and excessive operating temperatures. The unit operates from 1370 to 1400 MHz, delivering up to 1600 W of cw power into a 50-load. Due to its modular construction, the amplifier provides easy maintenance and permits flexibility in packaging configurations to suit individual installations. Input power required is 208 V ac, three-phase at from 47 to 420 Hz.

Microwave Power Devices, Adams Ct., Plainview, NY 11803. (516) 433-1400. **CIRCLE NO. 447**

Modem gives access to analog microwave nets

A direct-to-line group modem, System 3000, gives users access to analog microwave networks. A completely self-contained unit, the modem operates independently of any multiplex. The unit offers 48-kHz bandwidth access to any multiplex group frequencies in supergroups 1 to 16 (12 to 4028 kHz). System 3000, useful where no group equipment or carrier generation is available, will accommodate wideband data or twelve voice channels. Branching and group-to-group frequency translation, to feed light route spur radios, may be achieved with little more than dc power and signal paths provided by the fixed plant.

Western Multiplex, 70 Glenn Way, Unit 4, Belmont, CA 94002. (415) 592-8832. **CIRCLE NO. 448**

Finally, a CPU that minds its own business.

Announcing the HP 1000
Separate I/O processors let the

Our new HP 1000 L-Series is designed to give you outstanding processing performance—even in the most demanding applications.

The reason is our innovative distributed intelligence architecture. Each I/O interface has its own processor—made with our exclusive SOS LSI process—and its own direct memory channel. Which means each interface can control and monitor data transfers—without interrupting the central processor.

So the CPU can concentrate on its main job of computation.

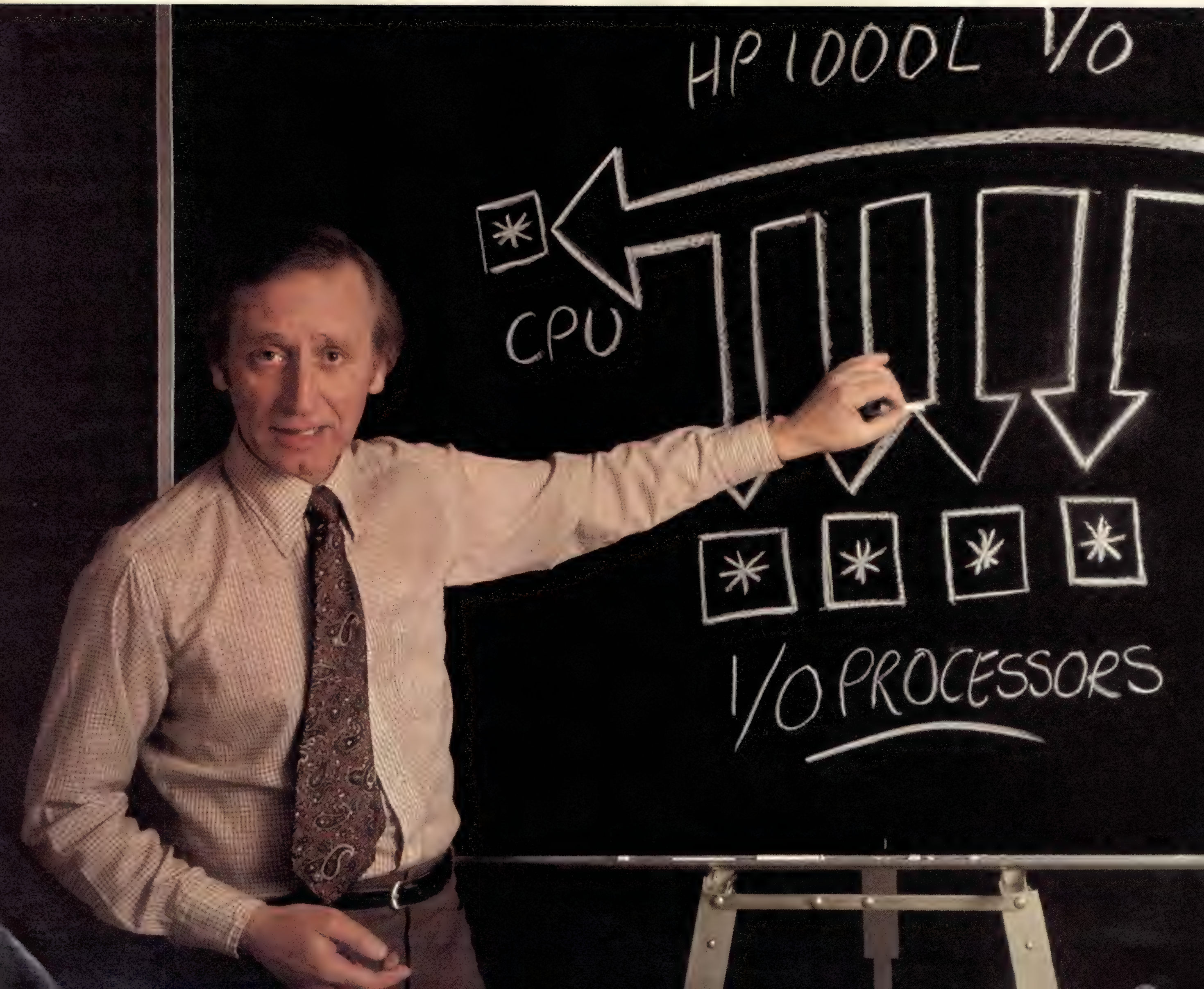
And you get faster response, higher throughput and superior system performance.

But what's really surprising about the L-Series is that you get all this performance at prices that start as low as $1968 for our starter set.† Or $15,510 for a complete disc-based system.††

Nobody makes processors like we do.

The key to the HP-1000 L-Series' impressive new architecture is our own Silicon-On-Sapphire technology. SOS lets us make CPU and I/O chips with extremely high circuit density, low power consumption, high processing speeds and high reliability—at a very low cost.

It's this combination of high performance and low cost that make the L-Series appropriate for the whole range of OEM and industrial appli-



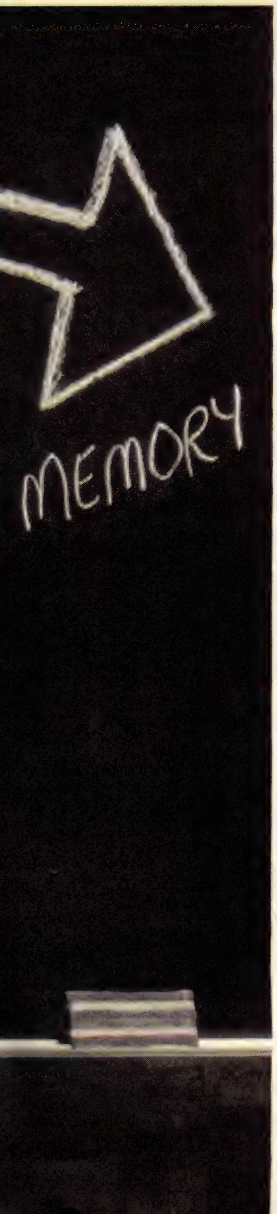
L-Series Computer.
CPU concentrate on computation.

cations — including data management, process control and instrumentation.

And to insure you can get the exact configuration you need for your specific application, the L-Series is available in a wide choice of board, box and system packages.

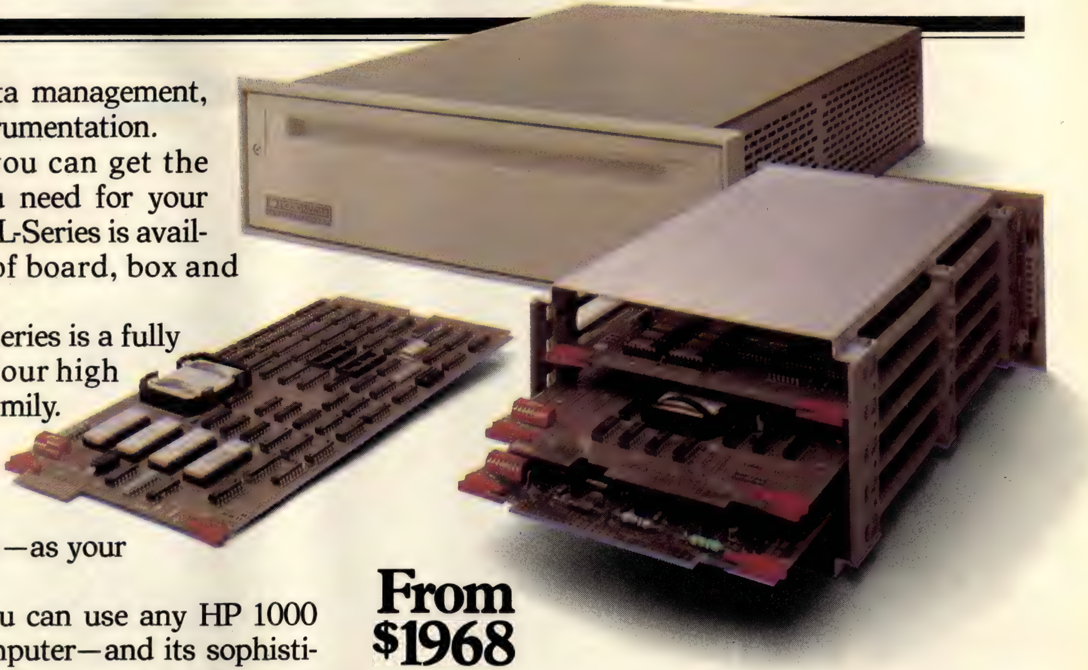
The HP 1000 L-Series is a fully compatible member of our high performance HP 1000 family. Which means you can move up to a larger computer—all the way to our powerful F-Series—as your application grows.

It also means you can use any HP 1000 computer—and its sophisticated program development tools—to design programs for the L-Series.



The reliability is built in.

Like all HP computers, the HP 1000 L-Series is designed to give you outstanding reliability. Reliability that's significantly enhanced by our SOS technology — processor boards have fewer active parts, so fewer things can go wrong. In addition, the L-Series has its own self-test programs and diagnostics.



From $1968

And, of course, the L-Series is backed by our full range of support and documentation services—including our worldwide service network.

For more information or a hands-on demonstration of our high performance, low cost L-Series, contact your nearest HP sales office listed in the White Pages or write to: Roger Ueltzen, Dept. 1473, 11000 Wolfe Road, Cupertino, CA 95014.

Coming soon to Los Angeles, Dallas, Chicago, New York and Toronto:

"Productivity '80: The Computer—Its *New* Role." Hewlett-Packard seminars and practical demonstrations on how to get more from your resources in the coming decade. Watch your local newspaper for details.

HEWLETT PACKARD

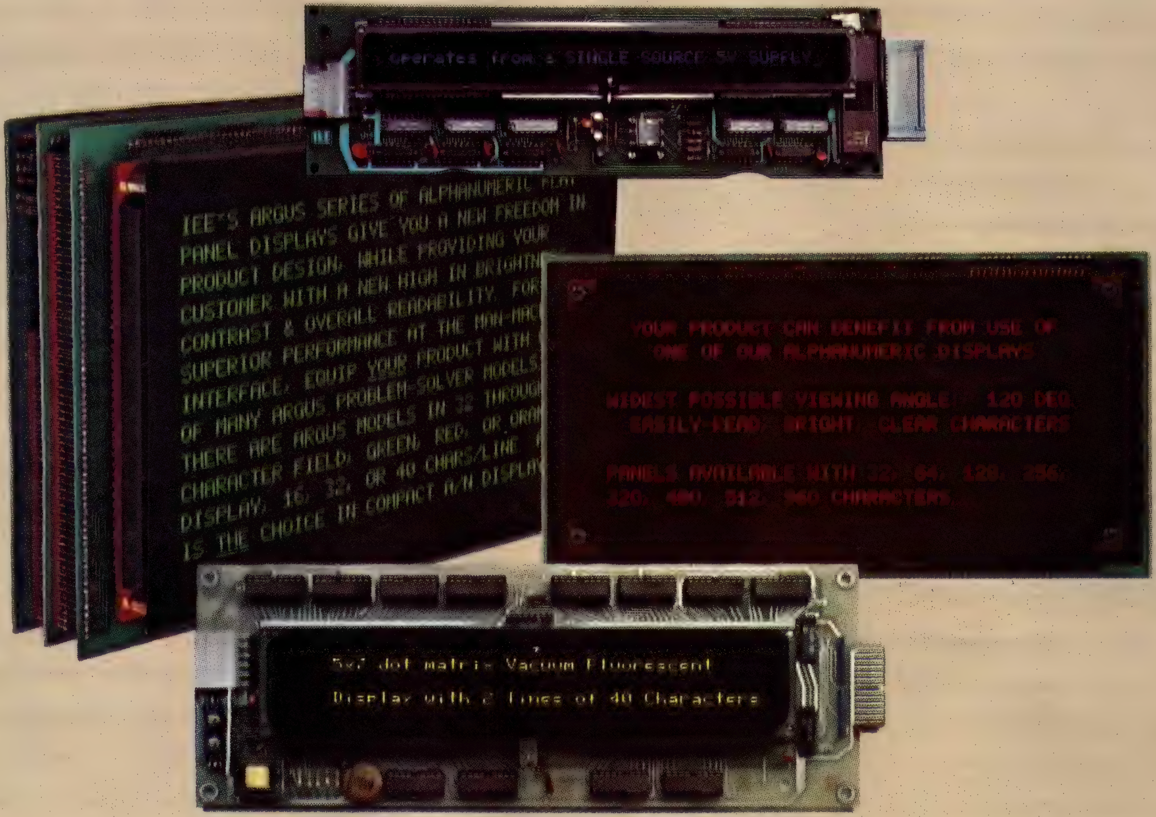
---

†Starter Set: CPU, 64KB memory, one I/O board.
††Disc-Based System: HP's new 12MB Winchester disc drive and 2621 display console.
(U.S. OEM prices in quantities of 100)

22002HPDS30

CIRCLE NO. 177

Smart *and* good-looking!


Operates from a SINGLE SOURCE 5V SUPPLY
IEE'S ARGUS SERIES OF ALPHANUMERIC FLAT
PANEL DISPLAYS GIVE YOU A NEW FREEDOM IN
PRODUCT DESIGN, WHILE PROVIDING YOUR
CUSTOMER WITH A NEW HIGH IN BRIGHTN
CONTRAST & OVERALL READABILITY. FOR
SUPERIOR PERFORMANCE AT THE MAN-MAC
INTERFACE, EQUIP YOUR PRODUCT WITH
OF MANY ARGUS PROBLEM-SOLVER MODELS
THERE ARE ARGUS MODELS IN 32 THROUGH
CHARACTER FIELD; GREEN, RED, OR ORAN
DISPLAY, 16, 32, OR 40 CHARS/LINE
IS THE CHOICE IN COMPACT A/N DISPLAY
YOUR PRODUCT CAN BENEFIT FROM USE OF
ONE OF OUR ALPHANUMERIC DISPLAYS
WIDEST POSSIBLE VIEWING ANGLE: 120 DEG.
EASILY-READ, BRIGHT, CLEAR CHARACTERS
PANELS AVAILABLE WITH 32, 64, 128, 256,
320, 480, 512, 960 CHARACTERS.
5x7 dot matrix Vacuum Fluorescent
Display with 2 lines of 40 Characters

IEE fills your intelligent alphanumeric display needs.

Choose from vacuum fluorescent or gas discharge engineered display modules.

IEE's FLIP vacuum fluorescent displays feature an operating voltage of only +5 VDC in a package depth of under one inch with .2 inch high characters and bright messages in yellow, green or blue. . .with only a filter change. FLIP is available with 1 line of 20, 1 & 2 lines of 40, 1 line of 80 and 6 lines of 40 characters. ASCII and European ECMA font sets are standard.

IEE's ARGUS gas discharge displays feature character heights of .21, .26 and .33 inch and a choice of orange, red or green display color. These minimum depth panels offer fields of 32 through 960 characters in up to 24 lines with 16, 32 or 40 characters per line.

Both technologies interface easily with your processor or other data source. All FLIP and ARGUS models are TTL/ASCII interface.

We are ***smart*** and we are ***good-looking***, so for your display needs, be smart and look to IEE!

IEE
The Display Maker

ALPHANUMERIC DISPLAY DIVISION

Industrial Electronic Engineers, Inc.
7740 Lemona Ave., Van Nuys, CA 91405
(213) 787-0311 TWX 910-495-1753

Please request additional information on your business letterhead.

Modem maintains Bell 212A compatibility

A dual-speed, Bell 212A compatible modem, Model 9212A, sends and receives full-duplex serial or binary data at up to 1200 baud. The modem works over the dial-up switched network or on two-wire leased lines. Operation is synchronous or asynchronous. Complete diagnostic capabilities include eight modem-status LED indicators. The modem will originate and automatically answer. A built-in dialer gives re-dial capability. An audio line monitor, with volume control, eliminates need for a separate telephone.

Omnitec, 2405 S. 20th St., Phoenix, AZ 85034. (602) 258-8244. $855; stock to 4 wks. **CIRCLE NO. 364**

Fiber-optic multiplexer sends eight channels

An 8-port multiplexer, MU8-1, transmits eight asynchronous RS-232C data channels at 20 kbits/s per channel. The unit sends all eight channels up to 1 km over a single duplex fiber-optic cable. The unit is also available in a 2-km configuration. Standard features include built-in monitoring and handshaking between multiplexer ends. By multiplexing data transfer without modems and associated cable, costs for a data-comm system can be reduced.

Valtec, 99 Harwell St., West Boylston, MA 01583. (617) 835-6082. $5995. **CIRCLE NO. 365**

Multiplexer squeezes 32 lines onto one

An intelligent data concentrator, the S-MUX 9103, permits replacement of up to 32 asynchronous data links by concentrating the data onto a single, high-speed link. Rates of up to 9600 bits/s are accommodated for asynchronous data communications while the device will operate at speeds of up to 19.2 kbits/s on the synchronous link. S-MUX 9103 automatically performs sophisticated statistical collection of traffic volumes, error events, buffer storage and similar data, allowing a user to keep track of channel utilization and overall performance. A friendly English language configuration protocol enables users to enter commands into the unit's microprocessor via a terminal keyboard. A buffer, with a 12,000-character capacity, provides peak-load smoothing and immunity to line-hit disturbances.

Gandalf Data, 1019 S. Noel Ave., Wheeling, IL 60090. (312) 541-6060. $3500. **CIRCLE NO. 366**

Kit yields two 20-Mbaud fiber-optic transceivers

A kit, featuring Motorola active fiber optic components and AMP Optimate connectors, assembles two TTL-compatible, 20-Mbaud fiber optic transceivers with bit error rates of 1×10^{-9}. The PC board layout allows use of the transceivers as transmit/receive stations in a full-duplex fiber optic data link or as repeaters in an optical data line. Once built, the modules can be probed and tested. The only interface requirement is for TTL levels and rise times.

AMP, 449 Eisenhower Blvd., Harrisburg, PA 17105. (717) 564-0100.
Electro: 2416 **CIRCLE NO. 367**

BIG POWER SUPPLIES

FOR SMALL SPACES

Save space, design time and solve your packaging problems…Our high density power supply design techniques provide up to 4 watts of output per cubic inch, and our exclusive Design-As-You-Order concept lets you specify your needs from off-the-shelf modules…no engineering charges or lost design time.

Standard unit highlights:

- **Inputs**—Single or dual—
  AC: 47 to 500 Hz
  DC: 12, 28, 48, 115 VDC
- **Outputs**—1 to 10 isolated—
  3 to 300 VDC (400 watts total)
  Up to 35 amps
- Efficiencies to 80%
- Conduction cooled—no air flow required!
- 100% Burn-In Tested

SPECIAL NEEDS? Why build your own special power supply when it may be in our catalog-Remember, packing a lot of power into a small box is our specialty!

Call or write for more information today!

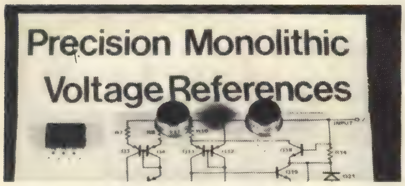
ARNOLD MAGNETICS

ARNOLD MAGNETICS CORPORATION

11520 W. Jefferson Blvd.
Culver City, Ca. 90230 ● (213) 870-7014

CIRCLE NO. 240

Voltage references draw low power

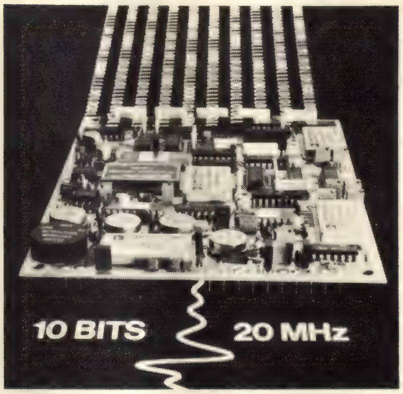


Two, precision, monolithic voltage references provide 5-V (MP5531A) and 10-V (MP5532) outputs with low power consumption. Both devices offer ±0.3% accuracy, a 1.4 to 10 mA regulating current range and an output which can be adjusted by greater than 3%. Noise is 10 μV pk-pk for the 5-V model and 20 μV pk-pk for the 10-V version. Tempco is only 3 ppm/°C.

Micro Power Systems, 3100 Alfred St., Santa Clara, CA 95050. (408) 247-5350. Typical $1.60 (100 qty); stock to 4 wks.

CIRCLE NO. 368

ADC doubles rate for radar analysis



MOD-1020, a 10-bit, 20-MHz analog-to-digital converter, permits users to double the sample rates in radar digitizers and extend spectrum analysis bandwidths. The hybrid board includes all circuitry needed for a complete, 10-bit conversion, such as track-and hold, encoder, timing logic, references and output latches. Only power supplies and an encode command must be furnished. Other uses for the board include improving picture quality in digital TV applications by increasing the grey scale resolution by a factor of four. Baseband signals can be digitized in secure communications applications. Features include compliance with pending SMPTE standards for balanced ECL compatibility, pin-selectable analog inputs of 1 V or 2 V pk-pk at 500 or 1000 Ω, a noise power ratio of 45 dB minimum, a 15-MHz large-signal input bandwidth and a 30-MHz small-signal input bandwidth. Nonlinearity tempco is 0.0005%/°C; gain tempco, 0.015%/°C.

Analog Devices Computer Labs, 505 Edwardia Dr., Greensboro, NC 27409. (919) 292-6427. $1795 (100 qty); stock.

CIRCLE NO. 369

New Heyco® Nylon Cable Clamps

New from Heyman Manufacturing—nylon clamps for standard and heavy duty cable applications. Tough, lightweight nylon resists abrasion, aging and most chemicals. And provides excellent insulation. Standard clamps range from ⅛″ thru ½″ in 7 sizes. Heavy duty clamp holds 19 different diameter cables, from ⅛″ thru 1½″. Both have standard locking holes. Both have full radiused inside edges that won't cut into wire insulation—and are open ended for easy entry. U.L. recognized. **FREE SAMPLES on request from:**

HEYMAN MANUFACTURING COMPANY
KENILWORTH, NEW JERSEY 07033 (201) 245-2345 • TWX: 710-996-5986
WAUKESHA, WISCONSIN 53187 (414) 542-7155 • TWX: 910-265-3668

Call Toll-Free (800) 558-0917 except from Wisconsin. If calling from Wisconsin use (800) 242-0985

HEYCO®

33D

DIRECTORY BLUES?

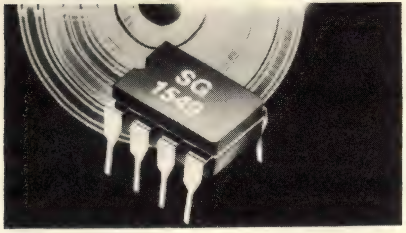
Chase them with GOLD BOOK. Some directories promise more than they deliver. You don't find the products you're seeking. You can't locate the manufacturer's address you need. Distributor directories have been eliminated. But check ELECTRONIC DESIGN's GOLD BOOK. Here you'll find the World's Most Complete Electronics Directory. Every effort has been made by the GOLD BOOK editorial staff to publish a listing on every known electronic component, sub-system, and system — and their manufacturers. Over 10,000 US and non-US manufacturers are listed, many with complete sales outlet listings (sales offices, reps and distributors). Two distributor directories (one alpha, one geo) and a trade name directory complete the editorial file. Specs on thousands of products provided by hundreds of manufacturers complement the editorial listings. Every time you need a directory — reach for GOLD BOOK. It's a sure cure for the blues.

"Over 108,000 Distributed Worldwide."

Electronic Design's
GOLD BOOK
THE WORLD'S MOST COMPLETE ELECTRONICS DIRECTORY

Hayden Publishing Company Inc.
50 Essex St., Rochelle Park, NJ 07662 • 201-843-0550

Current sense chip gives fast digital limiting



A current sense latch circuit, SG1549, uses digital, rather than linear, current limiting to protect switching-mode power supplies. The chip uses pulse-by-pulse sensing to cut current limit reaction time to less than 200 ns. Current build-up is monitored each time the power supply's switching transistor conducts. Upon sensing an overcurrent condition, the SG1549 immediately turns the transistor off and holds it off for the duration of the normally on period. The circuit includes a latch to prohibit the transistor from resuming conduction when the overcurrent signal is removed. Provision for reset is included. The digital current limiting technique eliminates the linear feedback loop, overcoming the stability and speed limitations inherent in the linear approach. Input threshold for the latch circuit is 100 mV. Reaction time is 180 ns. Common-mode input voltage can range from ground to 40 V. The SG1549 requires only 2 mA of supply current and comes in an 8-pin plastic or ceramic DIP.

Silicon General, 11651 Monarch St., Garden Grove, CA 92641. (714) 892-5531. $1.45 (100 qty); stock.

CIRCLE NO. 370

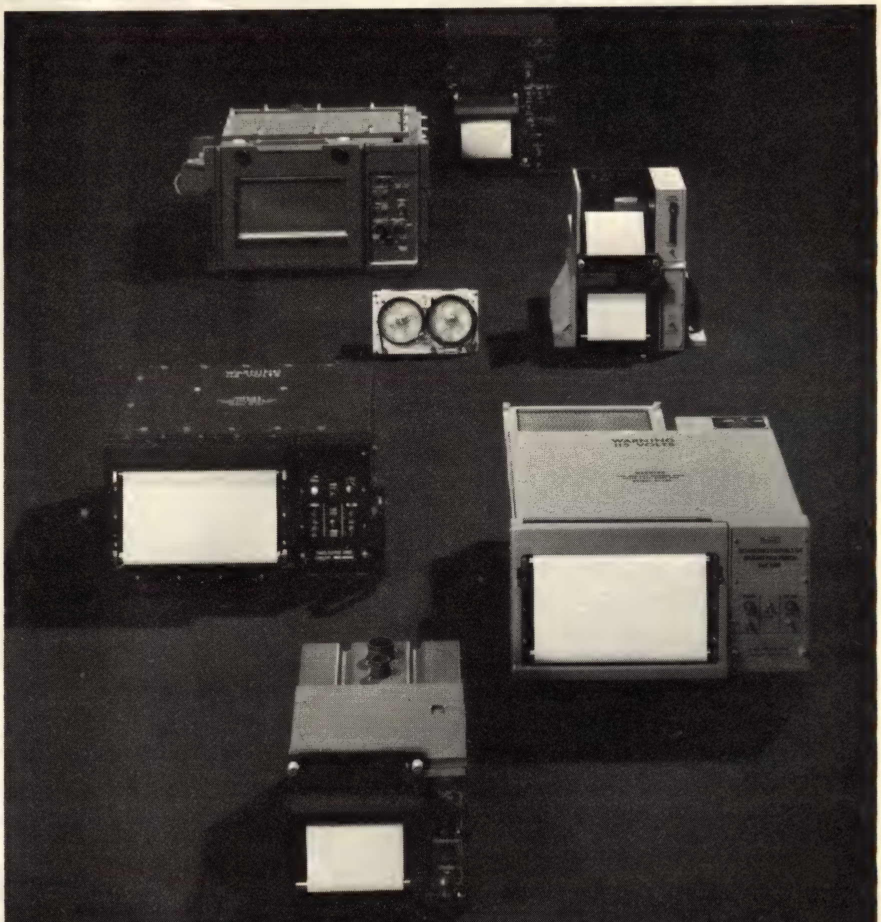
Drivers encode signals for LED bargraphs

A family of LED bargraph display drivers operates in tandem for displays of up to 10 elements. The devices drive linear and logarithmic indicators in receivers, signal-level displays, tuning scales and analog volt or ampere meters. The ICs encode a 1-V input signal. U237B and U247B offer minimum threshold levels of 0.2 V and 0.1 V respectively, both with 200-mV steps. U257B and U267B are logarithmic encoder/drivers. The first offers a minimum threshold level of −15 dB; the second, −20 dB. U244B and U254B provide a "soft" transition between LEDs, rather than an abrupt change. The display's status can reflect an intermediate transition stage when an input voltage passes through a given threshold level.

AEG-Telefunken, Rt. 22—Orr Dr., Somerville, NJ 08876. (201) 722-9800.

CIRCLE NO. 371

THE UNTOUCHABLES



Datametrics Corporation is a specialist, manufacturing only one product—high speed, non-impact printers.

We offer a large number of product variations within three basic printer models. An adaptable product line to meet your printer requirements.

DmC
Datametrics Corporation
7630 Gloria Avenue, Van Nuys, California 91406 • (213) 989-3840

CIRCLE NO. 181

glitch\'glich\ *n* [prob. fr. German *glitschen,* to slide] **1:** Originally, an unwanted, false electronic pulse. **2:** Now, any of a variety of problems that plague both hardware and software in digital designs. syn spike, snarp.

glitchfixer\'glich fik-ser\ *n* [only from Gould] **1:** A Biomation logic analyzer with 8, 9, 16, 27 or 32 channels, sampling rates to 200 MHz, and memory lengths to 2048 words. **2:** The ultimate solution to troubleshooting digital logic.

GOULD
An Electrical/Electronics Company
4600 Old Ironsides Drive, Santa Clara, CA 95050
For a Glitchfixer catalog, call Bob Lorentzen
at (408) 988-6800

CIRCLE NO. 182

MAGNETIC SHIELDING

Material For CRT's,
Transformers, Power Supplies,
PMT's, Relays & other components:

- CO-NETIC AA ALLOY — High Permeability .002″ to .100″ thick

  EXCLUSIVE: Perfection Annealed — No further anneal required if severe forming is avoided.

- NETIC S3-6 ALLOY — High Saturation Induction. .004″ to .095″ thick

MAGNETIC SHIELD DIVISION
PERFECTION MICA CO.
740 North Thomas Drive
Bensenville, Ill. 60106, USA
Phone 312 / 766-7800
TWX 910-256-4815

Send for NEW
Material, Application
and Fabrication
Guide MG-5

CIRCLE NO. 183

Data acquisition system does it all in 80-pin QUIP

A complete, hybrid data acquisition system, SDM854, offers 16-channel performance and 12-bit resolution within its compact, 80-pin package. The device accepts analog inputs over a ±10 V range. Accuracy is ±0.024% at a throughput rate of 27 kHz. The system includes an analog multiplexer, an address register, a sample-and-hold, a 12-bit ADC, a delay timer, a clock, a voltage reference and three-state output buffers to simplify 4, 8 and 16-bit data bus interfacing. The 80-pin QUIP ceramic substrate saves board space and offers total isolation. Its heat-sink properties allow chips to be directly mounted on the single substrate.

Burr-Brown, P.O. Box 11400, Tucson, AZ 85734. (602) 746-1111. $165 and $185 (100 qty); stock.

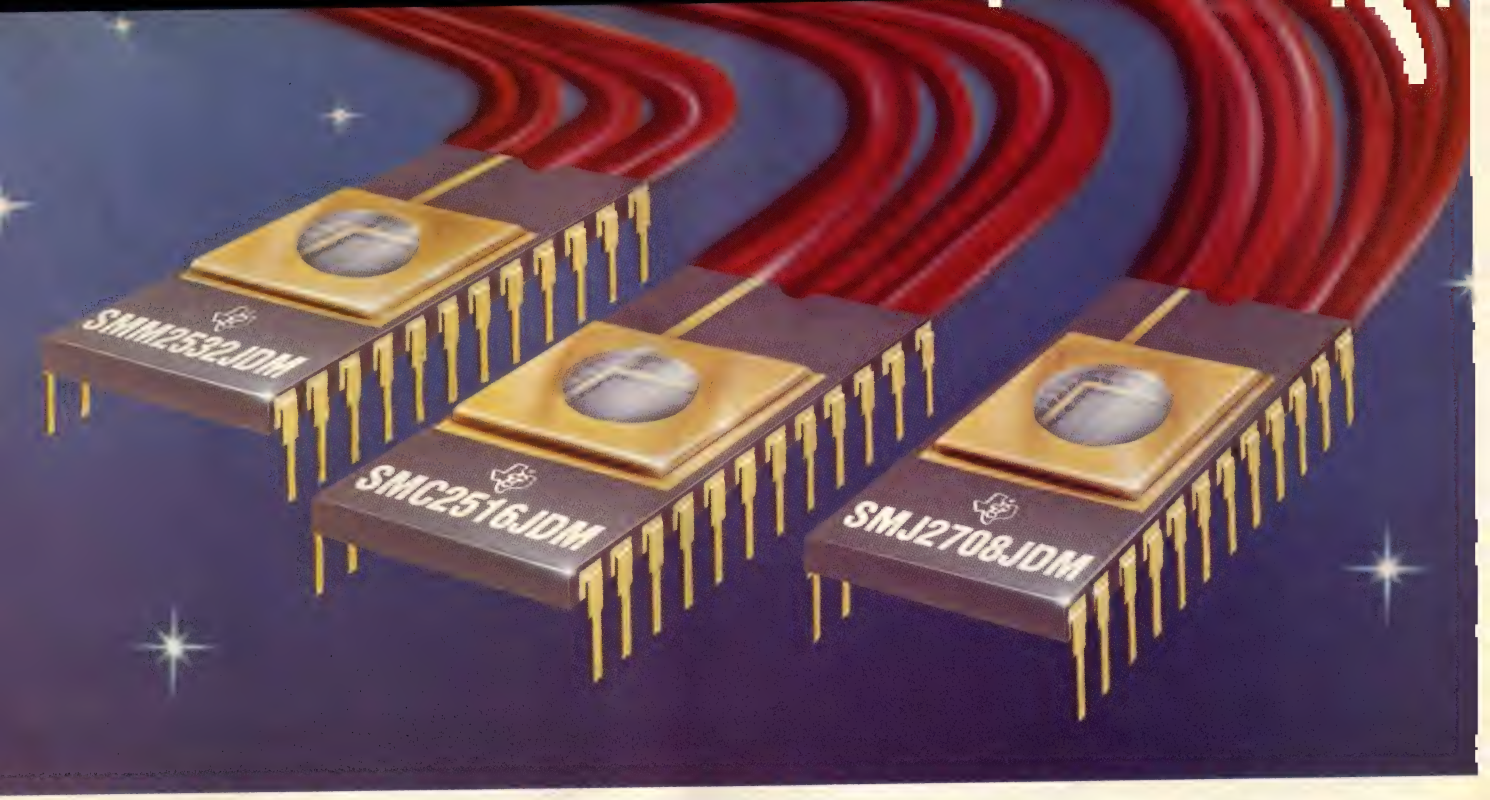
CIRCLE NO. 372

Op amp supplies a high-power output

A wideband operational amplifier, 1460, supplies a ±30V, 150-mA output. A full differential input, single-ended output device, the op amp gives designers a gain-bandwidth product of up to 1 GHz with slew rates of 300 V/μs. Maximum operating frequency is 10 MHz, making the 1460 suited for high-speed, high-gain configurations requiring 30-V, high-current outputs. Use of a VMOS output stage eliminates secondary breakdown problems. Supplied in an 8-pin, TO-3 package, the 1460 will operate from 0 to 70 C. Applications include use as a video amplifier, an analog signal amplifier or a digital signal booster.

Teledyne Philbrick, Allied Dr. at Rt. 128, Dedham, MA 02026. (617) 329-1600. $48 (100 qty).

CIRCLE NO. 373



The first family of -55 to +125° C military EPROMS is available now. From Texas Instruments.

Now, for the first time, systems designers can select from a full complement of military grade memories operational over the full temperature range, −55 to +125°C.

And, you can make that selection from TI's growing full temperature EPROM Family.

Processing and speed options

The military versions of TI's EPROM Family are available in three processing levels:

- SMM: Military processed
- SMC: 883B — Vendor equivalent
- SMJ: 883B

You can specify either the 2708 or 2516 in both 350 and 450-ns versions. The 2508, fastest 8K EPROM available anywhere, clocks in at 250 and 300 ns.

Low-power 8Ks, 16Ks and 32Ks

A 446-mW 2508 and a 525-mW 2516, standard 2708s and 2532s, along with their low-power versions, 27L08 and 25L32, dissipating 580 mW and 500 mW, respectively, offer the designer more flexibility than ever before.

Temperature options

For systems that don't require full temperature operation, check and choose from these cost-effective military processed options:

SUFFIX	OPERATION
L	0 to 70°C
C	−20 to +85°C
R	−55 to +85°C
S	−55 to +100°C
M	−55 to +125°C

Family compatibility and availability

All TI Military EPROMs are pin-compatible in rugged 24-pin dual-in-line ceramic packages.

Upgrading is simple because the family concept is designed in. Like all TI EPROMs, the military versions are also erasable, reprogrammable and upgradable. At any time.

All offer reliable, state-of-the-art performance and most are available off-the-shelf at your nearest authorized TI distributor.

Military systems designers can continue to depend on TI's firm commitment to innovative military memory products.

For performance. For reliability. For compatibility. For upgradability. For availability. For economy. And for speed.

For more information about TI's military EPROM Family, contact your distributor or TI local field sales office. Be sure to ask about TI's military versions of static and dynamic RAMs. For details, write to Texas Instruments Incorporated, P.O. Box 225012, M/S 308, Dallas, Texas 75265.

Fifty Years of Innovation

TI's Growing Military EPROM Family

DEVICE	TEMP RANGE +	PROCESSING LEVEL*	OPERATING MAX POWER STD	OPERATING MAX POWER LOW POWER	ACCESS TIME ns	ORGANIZATION
2532	L,C,R,S,M	SMM, SMC, SMJ, 883B	840 mW	500 mW	450	4K x 8
2516	L,C,R,S,M	SMM, SMC, SMJ, 883B	525 mW		350, 450	2K x 8
2508	L,C,R,S,M	SMM, SMC, SMJ, 883B	446 mW		250, 300	1K x 8
2708	L,C,R,S,M	SMM, SMC, SMJ, 883B	800 mW	580 mW	350, 450	1K x 8

*SEE PROCESSING OPTIONS

TEXAS INSTRUMENTS
INCORPORATED
CIRCLE NO. 184

©1980 Texas Instruments Incorporated

82914A

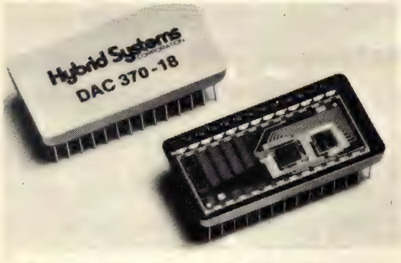
Chip set produces high quality speech

A speech synthesis system, based on the SPC or Speech Processor Chip, produces high-quality speech in male, female or children's voices. SPC consists of multiple NMOS circuits, including the speech processor and speech ROM. An external filter, audio amplifier and speaker are required. The chip set is not constrained by the kind of microprocessor being used and will easily interface to low-cost microcontrollers, such as National's COPs family. SPC uses waveform digitization with compression. This technique minimizes the amount of logic hardware and memory needed since a compression algorithm has more modest memory needs. In operation, the processor communicates with the speech ROM, which contains the compressed speech, as well as the frequency and amplitude data needed for speech output. Up to 128 kbits of speech can be directly accessed. On-chip switch debounce is provided to facilitate interfacing to manual switches.

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. Approx. $12.00 (OEM qty).

CIRCLE NO. 374

Input registers store data for 16-bit DAC



Input storage registers provide data storage for a 16-bit linear, 18-bit resolution hybrid DAC, the DAC 370-18. The device contains two chips—a monolithic CMOS chip containing switches, storage registers and other electronics. A proprietary thin-film chip provides all necessary resistors. Data conversion can be performed continuously or from stored data. The storage registers are in two 8-bit and one 2-bit segments with independent level-triggered latches. DAC370-18 is compatible with most microprocessor data bus interfaces. The device requires a single 15-V supply and is TTL, DTL and CMOS compatible. A commercial version and a military model are offered.

Hybrid Systems, Crosby Dr., Bedford, MA 01730. (617) 275-1570. $159 (commercial); $470 (military); 6 to 12 wks.

CIRCLE NO. 375

Solid-state thermostat packs circuit on hybrid

A precision hybrid, solid-state thermostat measures temperature and controls and switches loads to 5 A. Tolerance on opening temperature is ±2 F. The control band from turn-off to turn-on is ±0.5 F. The device measures 0.5 × 1.5 × 0.16 in. When a thermister is integrally mounted on the chip, maximum temperature capacity is 167 F. Maximum temperature capability increases to 325 F when the thermostat uses an external thermistor. The solid-state thermostat eliminates problems associated with mechanical types, such as vibration or interference caused by the physical opening and closing of contacts. Fewer solder connections result in improved reliability over controllers using discrete components. The hybrid uses zero-crossing switching.

Sierracin/Thermal Systems, 13920 S. Broadway, Los Angeles, CA 90061. (213) 321-4350. $5 to $20.

CIRCLE NO. 376

HAYDEN TAPES ARE NOT SOMEWHERE OVER THE RAINBOW...

SLOW LIST/STOP LIST (Gilder) Start, stop, and control the speed of your program with Apple II's game paddles. Control the speed at which the disk catalog appears and terminate CATALOG operation in the middle. The program can be enabled and disabled under software control. **#03904, Apple II, $10.95**

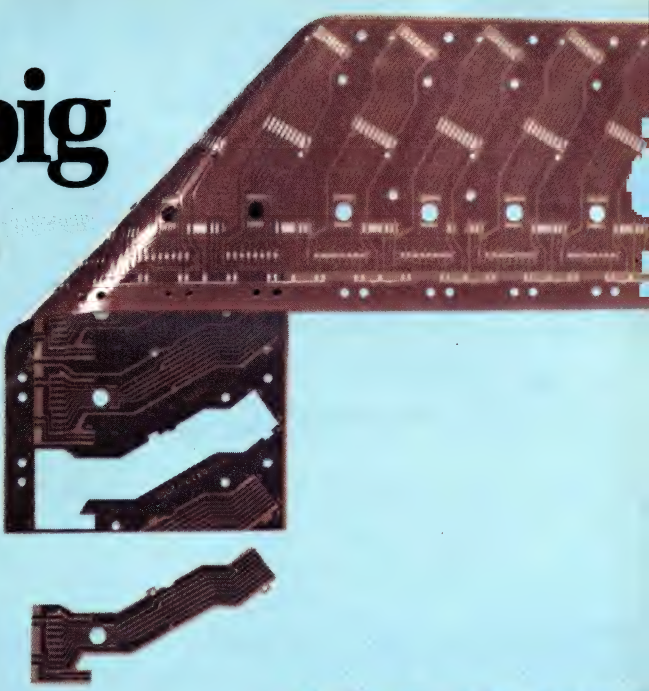
REVIVE (Gilder) When a program is accidentally erased, REVIVE searches through memory and finds the information that enables it to restore the pointers that have been changed. Can be loaded at any time, even after you have accidentally erased the program. **#03604, Apple II, $19.95.**

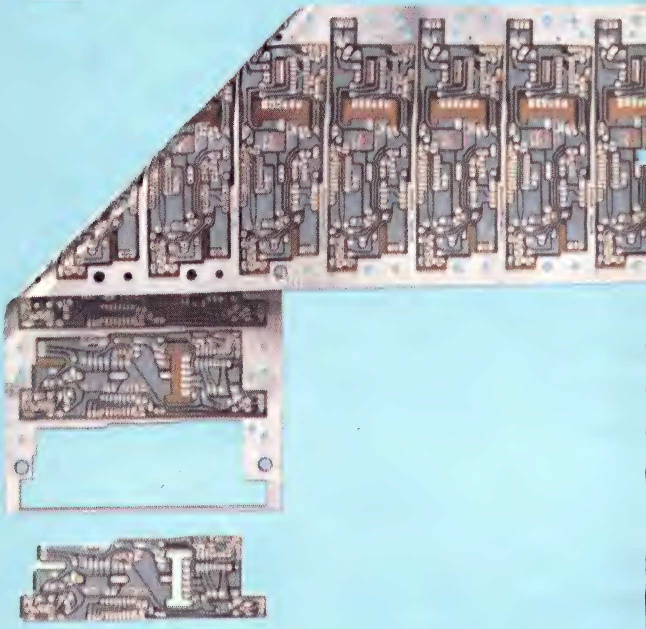
SONGS IN THE KEY OF APPLE (Lopatin). Allows you to see and hear your favorite tunes, pre-programmed tunes, or music you create (up to 200 notes, including rests per musical piece). Multi-color graphics accompany all music. **#03304, Apple II, $10.95.**

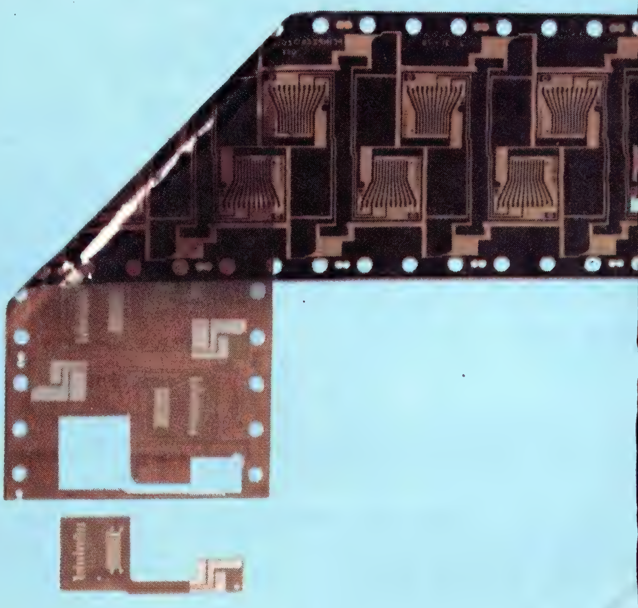
APPLESOFT UTILITY PROGRAMS (Gilder) Contains 9 subroutines, among them 3 different statement formatters: REM, PRINT, and Pokewriter. Other subroutines included are: calculating the decimal address of your machine language program, checking for illegal branches and indicating where one exists, joining two or more programs together, etc. **#03504, Apple II, $29.95.**

They're Down To Earth And At Your Local Computer Store!

Hayden Book Company, Inc.
50 Essex Street, Rochelle Park, NJ 07662







When you go big in flex circuits

Go right with Rogers.

If your usage of flexible circuits will be high volume, start your new project with a company that can deliver.

Rogers' unique in-house capability to meet demanding requirements for flexible laminates gives you a flying start on truly cost-effective flexible circuitry. Roll-to-roll processing in greatly expanded production facilities further contributes to economy.

Rogers has in-depth engineering support for your program and responds promptly to requests for application engineering assistance. One call to (602) 963-4584 will put you on the way toward uniformly reliable, high-volume flexible circuits.

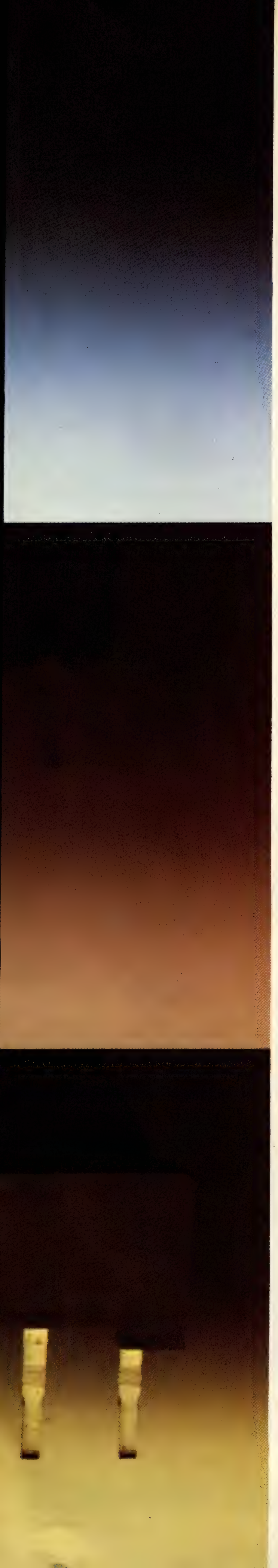
Circuit Systems Group
Rogers Corporation
Chandler, Arizona 85224
(602) 963-4584

ROGERS

EUROPE: Mektron NV, Gent, Belgium JAPAN: Nippon Mektron, Tokyo

CIRCLE NO. 94 **CIRCLE NO. 96**

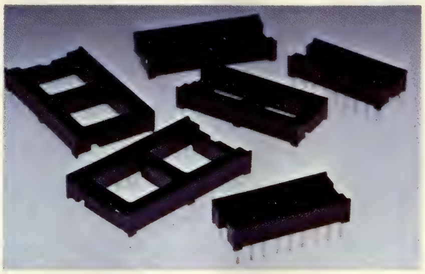
BERYLLIUM COPPER,
COPPER ALLOY,
OR GOLD INLAY.



NOW YOU GET AUGAT RELIABILITY, LOWEST PRICES AND A CHOICE OF CONTACTS.

Which low-cost, high-reliability 200 Series socket is best for your application?

Here are the facts.



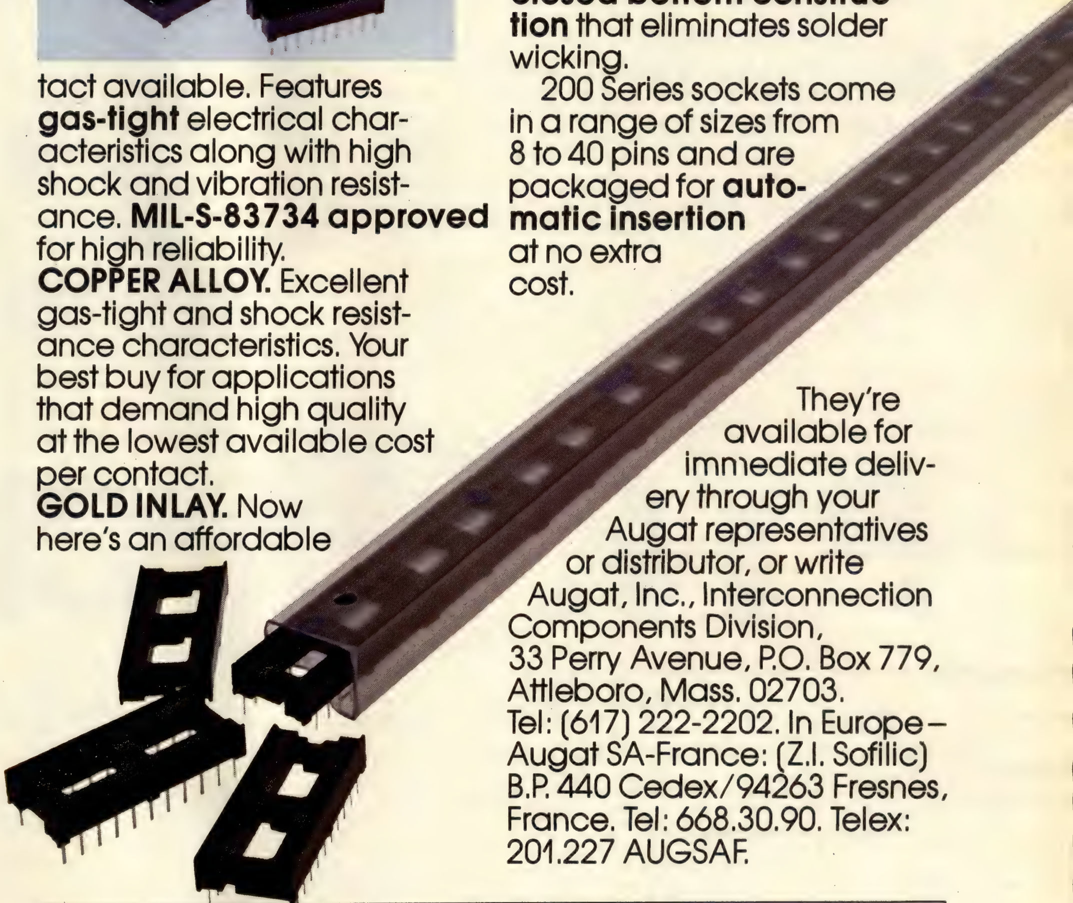
BERYLLIUM COPPER. The highest quality low-cost contact available. Features **gas-tight** electrical characteristics along with high shock and vibration resistance. **MIL-S-83734 approved** for high reliability.

COPPER ALLOY. Excellent gas-tight and shock resistance characteristics. Your best buy for applications that demand high quality at the lowest available cost per contact.

GOLD INLAY. Now here's an affordable gold socket. Gives you gold where you need it – at the contact point. Establishes a new gold standard for dependability and economy.

And no matter which 200 Series low-cost production socket you choose, you get Augat's superior mechanical features, **low profile construction** with **end and side stackability** and **closed bottom construction** that eliminates solder wicking.

200 Series sockets come in a range of sizes from 8 to 40 pins and are packaged for **automatic insertion** at no extra cost.



They're available for immediate delivery through your Augat representatives or distributor, or write Augat, Inc., Interconnection Components Division, 33 Perry Avenue, P.O. Box 779, Attleboro, Mass. 02703. Tel: (617) 222-2202. In Europe – Augat SA-France: (Z.I. Sofilic) B.P. 440 Cedex/94263 Fresnes, France. Tel: 668.30.90. Telex: 201.227 AUGSAF.

TEST DATA	
Insertion Force	230 grams when measured with a .015" x .023" rectangular lead.
Withdrawal Force	88 grams when measured with a .008" x .015" rectangular lead.
Initial Contact Resistance Per MIL-STD-1344, Method 3002	Low-signal level contact resistance at 20 mv open circuit measured at 6.79 milliohms, before corrosive atmosphere.
Socket Durability 50 Cycles with .014" x .021" Gauge	5.4 milliohms measured before durability and 6.15 milliohms after 50 cycles.
Corrosive Atmosphere per MIL-S-83734 Para. 4.7-16	No evidence of porous plating or exposure of base metal. Contact resistance averaged 6.64 milliohms indicating gas tight performance. Low-signal level 100 ma at 20 mv.

Your contacts are on the next page, too. Look for Augat's complete distribution listing.

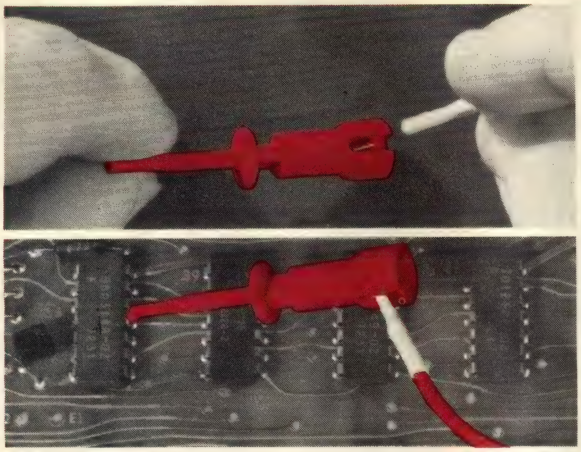
Send for detailed Augat test report #178

AUGAT®

CIRCLE NO. 186

Augat interconnection products, Isotronics microcircuit packaging, and Alco subminiature switches.

E-Z-HOOK®
PROBLEM SOLVER NO. 1



XM25 WITH BUILT-IN .025″ SQUARE POST SNAPS ONTO SQUARE SOCKET JUMPERS.
Built-in post connects to .025″ Square or .030″ Round Sockets. Hook spans leads up to .025″ dia. will connect over single leg of DIP, barrier built-into tip prevents shorting between legs of the IC. **Construction:** One-Piece BeCu, Gold-Plated Conductor and Hook. Heat and Chemical Resistant Nylon Body. Stainless Steel Spring. **Colors:** 10 Solid Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray, White PLUS Kilo-Color capability of 1000 combinations.

SEND FOR COMPLETE CATALOG AND PRICE LIST

E-Z-HOOK®
A DIVISION OF TEKTEST, INC.
MAILING ADDRESS: P.O. BOX 450
ARCADIA, CALIFORNIA 91006
(213) 446-6175 / TWX 910 582 1614

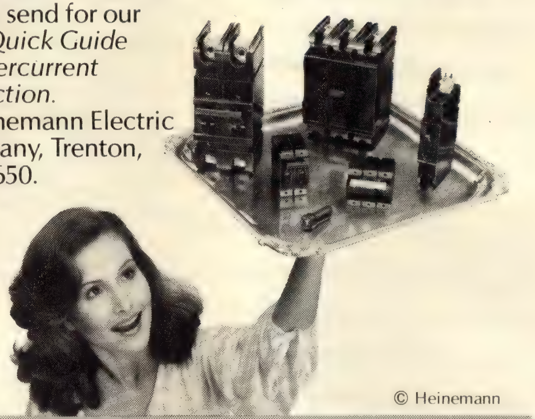
CIRCLE NO. 179

PRECISION PROTECTION from 0.01A to 250A.

Heinemann—the only independent manufacturer of fully-magnetic circuit breakers—offers you the widest choice of current and voltage ratings, short-circuit capacities, handle styles and colors, time delays (or instantaneous trip), special internal circuits for control as well as overcurrent protection.

And now you can get our most popular breakers from stock at your nearest authorized Heinemann distributor's. For special models or technical assistance, call toll-free 1-800-257-9590; and meanwhile, send for our new *Quick Guide to Overcurrent Protection.*

Heinemann Electric Company, Trenton, NJ 08650.



7314 © Heinemann

HEINEMANN We serve you better

CIRCLE NO. 178

PTK lights CRT's

HIGH VOLTAGE FOR CRT APPLICATIONS

COMMERCIAL → C-100 Series
2 to 30kV, 3 to 30 watts, high voltage power supplies. Custom flyback transformers.

MILITARY
Mil grade units for ground, ship and aircraft.

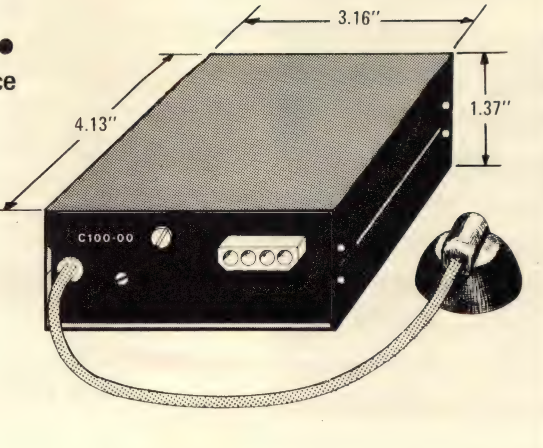
L.V. / H.V. COMBO'S
High voltage power supplies combined with a multiple output low voltage switcher.

SPECIALS
Miniature and sub-miniature high voltage power supplies to 20kV. Ultra stable or ultra low ripple designs.

H.V. CONNECTOR & LEAD ASSEMBLIES
Amp LGH types to 20kV.

For technical assistance or pricing call Wayne Hamari toll free (outside California) 1-800-235-4148

MAJOR FEATURES:
Low Cost ● 2 to 22kV at 10W ● Excellent Transient Performance ● Focus and G1 Bias Voltages to ± 1kV ● Standard Input +26V ± 10% ● Demonstrated MTBF > 100,000 hours ● UL Recognized for Medical Applications ● Input, Output Mounting and Connector Options available ● 3 YEAR WARRANTY



PTK Corporation 1173 Los Olivos Avenue, Los Osos, CA 93402 (805) 528-5858

CIRCLE NO. 187

Math package exploits arithmetic processors

A modular arithmetic real-time package for 8080/8085 and Z80-based systems, MART, exploits the capabilities of the AMD 9511/12 arithmetic processors. MART simplifies interaction between application programs and the arithmetic device through a multilayered hierarchical architecture. Application programs interface directly with any level of control at any time, without causing system or device corruption. At the highest level, programs may submit expressions in Infix notation in ASCII representation. At the lowest level, a program may submit a formatted "Execution Stack" directly to the device driver. MART allows asynchronous operation at the hardware level through interrupt control and by arbitrating the use of the arithmetic devices by multiple programs.

Systems & Software, 2801 Finley Rd., Suite 101, Downers Grove, IL 60515. (312) 932-9320. $750.

CIRCLE NO. 377

Screen driver guides Dasher terminals

C-Rite, a screen driver utility, creates, displays and edits data, text and files on Dasher terminals. The software uses data encryption techniques to store ASCII data in compacted format. C-Rite interfaces with Basic, Assembler and Macro-assembler programs. Standard program function keys are used to manipulate text quickly and easily. Cumbersome I/O statements are eliminated.

Country Programmers, Main St., Fairlee, VT 05045. (802) 333-4211. $195 **CIRCLE NO. 378**

Cross assembler suits the F8/3870 family of μPs

A cross assembler answers the needs of F8/3870 microprocessor users with systems operating under Digital Research's CP/M operating system. Source code input is in a form similar to source code input for MAC or ASM. An optional output consists of list and/or object files. The listing file paginates, prints page headings and produces a symbol table. The object file is ready to download into a Fairchild or Mostek development system. The cross assembler is supplied in a single-density, 8-in. floppy disk.

Warner Associates, P.O. Box 134, Los Gatos, GA 95030. (408) 356-1090. **CIRCLE NO. 379**

Diagnostic Emulator™ for Z-80* Microprocessor Support

- **Real time trace memory**
- **Tandem breakpoints and scope loops**
- **User programmable diagnostics**
- **Portable stand-alone emulation**

Engineering Development
Software and Hardware Integration
Production Testing
Functional Test and Rework
Field Servicing
Portable Field Trouble-Shooting

FOR INFORMATION
CALL **(206) 823-9911**

APPLIED MICROSYSTEMS 11064 118th PL N.E. KIRKLAND, WA 98033

* Z-80 is a reg. Trademark of Zilog, Inc.

CIRCLE NO. 188

Beckman breaks the cost barrier in thin-film networks.

Now you can get the precision performance of thin-film networks at the low cost of metal-films. Our large volume production and extensive experience in resistor networks makes this low cost possible.

Our 14- and 16-pin DIP's, models 699 and 698, with their close ratio matching and exceptional temperature tracking, have the high performance of matched resistor sets, yet the per resistor price of individuals discretes.

Using Beckman thin-film resistor networks results in more savings than just their direct cost, however. You also reduce component count, assembly costs and inventory levels.

Finally, thin-film networks can ease your reliability worries with their long-term accuracy and temperature stability. Whether you're using wirewound or metal-film resistors, Beckman's thin-film networks offer you a superior alternative. In both performance and cost.

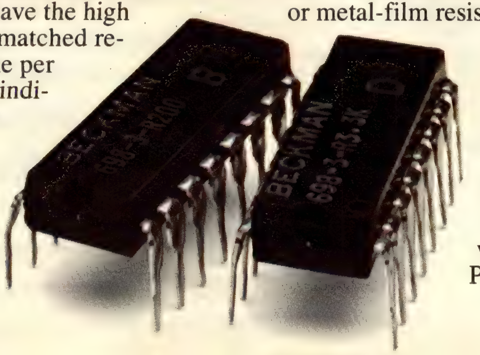
Call your local Beckman representative today, or write: Network Products Operations, Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, CA 92634. In Europe write: Beckman Instruments (Belgium) S.A., 14, Avenue Hamoir, 1180 Bruxelles, Belgium. Telex: 23577

- Low cost...comparable to metal-film discrete resistors.
- 1% to 0.1% resistor tolerances available.
- 0.1% ratio accuracy.
- ±50 P/10^6/°C tempco for improved environmental stability.
- ±5 P/10^6/°C tracking.
- Saves cost in manufacturing, stocking and inspection.

Design Beckman thin-film in.
Design problems out.

BECKMAN

CIRCLE NO. 189



Graphics plan gauges component fatigue life

COMpac 7004, an interactive computer graphics package, develops estimates of the fatigue life of a component subjected to variable amplitude and variable mean loading. The software allows engineers, without special computer or software training, to perform calculations and immediately view the results, pictorially, on a Tektronix 4050 series computer. The program allows fatigue life estimates directly, following a process stage by stage and ascertaining the effect of modifications of geometry, material or loading on the life of a component. COMpac 7400 includes a user's manual, together with three Data Items and a program available on a DC-300A data cartridge.

Engineering Sciences Data Unit, Suite 1037, 733 15th St., N.W., Washington, DC 20005. (202) 638-0055. **CIRCLE NO. 426**

Computer system gives a CPU to all four users

A multi-user microcomputer, the Z-System, offers a discrete CPU and 64-k of RAM to each user. Up to four users are supported. Each user can execute any CP/M software using the transient program area provided for each station. Different users can simultaneously run programs coded in different languages. Any standard CP/M program is executed at each workstation, while a Master Z-80A CPU runs an enhanced version of MP/M, arbitrating bus usage and performing I/O functions for the satellite stations. The system is fully interrupt driven for fast operation. A four-user system with hard disk requires only eight circuit boards.

Micromation, 1620 Montgomery St., San Francisco, CA 94111. (415) 398-0289. **CIRCLE NO. 427**

for best results...
first convert to IMC

IMCube VANEAXIAL FAN

This easy to install, one inch cube powerhouse does wonders for spot cooling critical components. It's called the IMCube and delivers air at 11,000 times its own volume each minute. Also available in one inch diameter cylinder configuration. Literature on request! For further information please call E. V. Lauria, Sales Manager at 516/334-7070 or write:

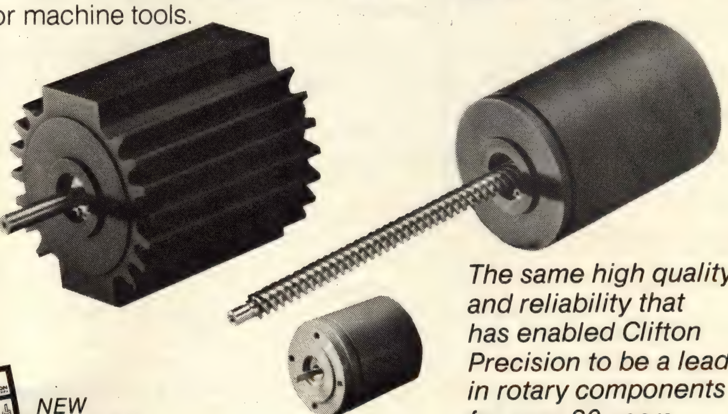
400 HZ

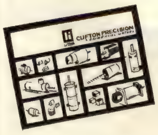
imc
IMC MAGNETICS CORP.
EASTERN DIVISION
570 MAIN STREET, WESTBURY, NEW YORK 11590

CIRCLE NO. 190

PM AND VR STEPPER MOTORS
with Ceramic, Alnico or Rare-Earth Magnets

Motors range from Size 8 to 42, with step angles 1.8°, 3.6°, 7.5°, 15°, 30°, 45°, and 90°. Applications include printer platen drives, printer wheel drives, floppy disk drives, card sorters, office copiers and *X-Y-Z drives* for machine tools.





NEW CATALOG NOW AVAILABLE

The same high quality and reliability that has enabled Clifton Precision to be a leader in rotary components for over 30 years.

Call (215) 622-1000

Litton
CLIFTON PRECISION®
MARPLE AT BROADWAY, CLIFTON HEIGHTS, PA. 19018

CIRCLE NO. 191

Auto-tester qualifies silicon and SOS wafers

A fully automatic wafer flatness tester, Auto-Sort, qualifies silicon, SOS and GGG-type wafers. Each wafer is flat-aligned, centered, analyzed and sorted by flatness criteria established by the user. The wafers are then reloaded into cassettes. Three different sort parameters can be used: peak-to-valley flatness (TIR), focal-plane deviation (FPD) and focal-plane yield (FPY)—the percent of a wafer's surface area within a certain distance from the focal plane.

Tropel, 1000 Fairport Park, Fairport, NY 14450. (716) 377-3200. **CIRCLE NO. 432**

Ruggedized Microcomputer

It's Easy to Design Your Severe Environment System Using our Ruggedized Version of Intel's 80/10A Microcomputer and Versatile Support Modules.

SECS 80 is a ruggedized version of Intel's iSBC* single-board computer. Even uses the same development system software.

Meets MIL-E-5400, 4158, 16400, making it perfect for military, avionics, and tough industrial environments.

SECS 80 comes with a multitude of support modules: RAM, ROM, EPROM, digital tape recorder and controller, 1553 interface, A-D converter, digital I/O, high-speed arithmetic unit, and more.

You can buy a complete system or configure your own with individual modules. Either way, this versatile microcomputer system will save you valuable time and development costs.

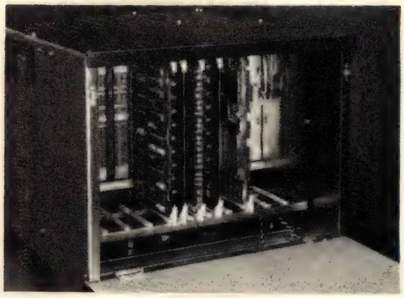
Phone or write for complete details today.

*Trademark of Intel Corporation

EMM SESCO
Severe Environment Systems Company
A Subsidiary of Electronic Memories & Magnetics Corporation
20630 Plummer Street • P.O. Box 668 • Chatsworth, California 91311
Telephone: (213) 998-9090 • Telex: 69-1404

CIRCLE NO. 192

μC chassis loads boards from the front



A microcomputer chassis permits insertion of micromodule cards from the front, rather than the top. The chassis, Part Number M68MMFLC1, includes a built-in power supply for 110 or 220-V ac operation, a card cage with a 14-slot motherboard (for up to 2-MHz operation) and two cooling fans.

Motorola Semiconductor Products, P.O. Box 20912, Phoenix, AZ 85036. Bill Crawford (602) 962-2219. $995.

CIRCLE NO. 433

Polarized connectors protect contacts

Self-locking, cylindrical connectors, B Series, use a shell-based guide and keyway polarization system to protect contacts. Shells are machined from brass and are satin-chrome-plated. The polarization system eliminates the possibility of damage to contacts if the connector is mismated. The locking mechanism is recessed in the shell to protect it from damage if the plug is dropped or stepped on. Connectors are initially available in four shell sizes with from two to 30 contacts. Minimum outside diameter for a five-contact version is 0.374 in., increasing to 0.709 in. for a 30-contact model.

Lemo U.S.A., 335 Tesconi Circle, Santa Rosa, CA 95401. (707) 523-0600. Typical $12.92 (100 qty); stock to 12 wks.

CIRCLE NO. 434

From the graphics leader.

Our design-size desktop computer. Precise. Productive. Interactive graphics. Precision for details like yours.

The Tektronix 4054 desktop graphic computer is perfect for the big, intricate, fine-line demands of electronics design. It features a 19-inch version of our exclusive, high-resolution display technology. The 4096 x 3125 resolution provides over 13 million addressable points, so it can deliver the large scale and minute detail you're looking for.

16-bit processor leverage. With 32K bytes of memory, expandable, and computational capabilities far beyond the scope of most desktop computers, you can do more analysis. Get more results. Get all the advantages of a system built for graphics.

Desktop convenience and graphic interactivity. You can include a Dynamic Graphics option that lets you create, position and assemble complex designs, without time-consuming erasures or corrections. Results come easy with our graphically-enhanced BASIC software and a wealth of applications assistance in our PLOT 50 library. You can choose from a full complement of Tektronix peripherals including mass storage devices, graphic tablets and digital plotters.

Draw your own conclusions. For a desktop demonstration call, toll-free, 1-800-547-1512. In Oregon, 644-9051 collect. Or write:

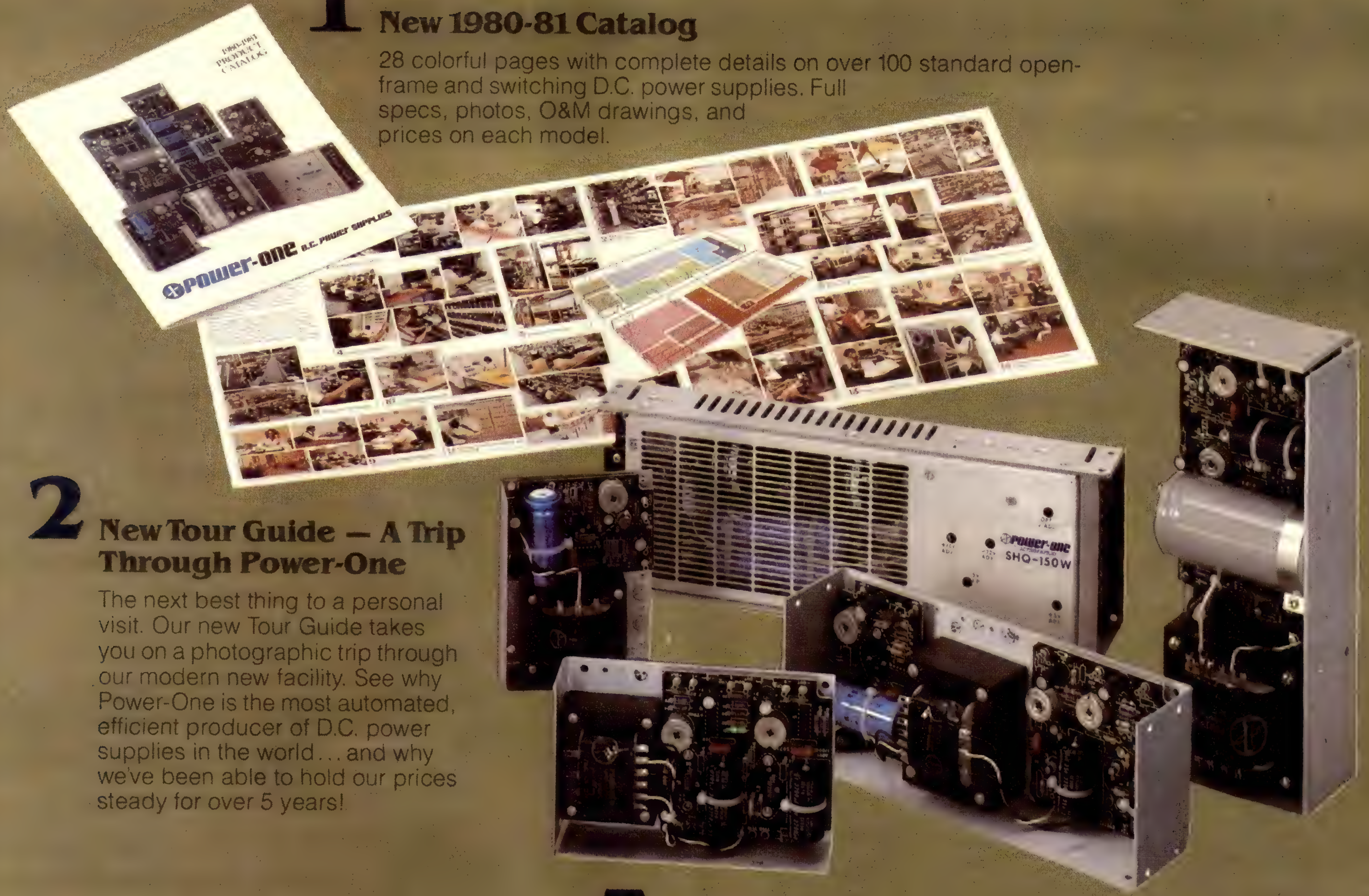
Tektronix, Inc.
Information Display Division
P.O. Box 500
Beaverton, OR 97077

Copyright © 1979 Tektronix, Inc. All rights reserved.
OEM information available on request.

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE NO. 193

Three Best Sellers for the 80's



1

New 1980-81 Catalog

28 colorful pages with complete details on over 100 standard open-frame and switching D.C. power supplies. Full specs, photos, O&M drawings, and prices on each model.

2

New Tour Guide — A Trip Through Power-One

The next best thing to a personal visit. Our new Tour Guide takes you on a photographic trip through our modern new facility. See why Power-One is the most automated, efficient producer of D.C. power supplies in the world... and why we've been able to hold our prices steady for over 5 years!

3

New Open Frames and Switchers... At Our Same Old Prices!

More new open-frames to choose from — plus new special-purpose models for specific applications such as Microprocessor and Floppy-Disk systems. Also, Power-One now offers a growing line of switching D.C. power supplies with the same quality and high reliability as our open-frame models.

So Act Now...
Get Our Free "Best Sellers" Today!

Mail coupon ➧
for fast action or
phone us direct.

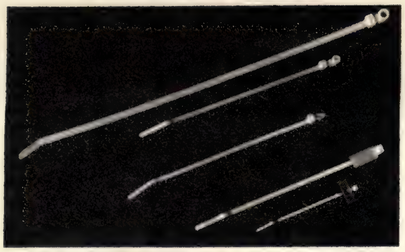
Rush Me Power-One's New Catalog and Tour Guide!

Name ______________________________
Company ____________________ Title ____________
Address ______________________________
City ____________________ State ____________
Zip ____________ Phone ____________________

POWER-ONE
D.C. POWER SUPPLIES
Power-One, Inc. • Power One Drive • Camarillo, CA 93010
Phone: 805/484-2806 • 805/987-3891 • TWX: 910-336-1297

CIRCLE NO. 194

Textured tabs mark bundled cables

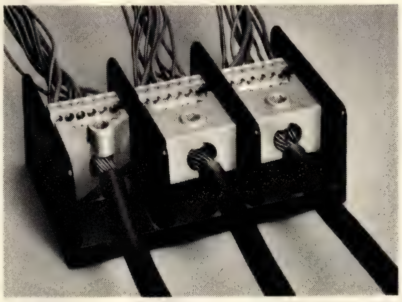


Miniature and standard size Identification Cable Ties use textured tabs that can be marked with permanent ink. The miniature version has a minimum loop tensile strength of 18 lb for bundle diameters from 3/16 to 15/16 in. The standard size handles bundle diameters from 3/8 to 1-3/4 in. Both types are made of Type 6/6 Nylon and can be applied by hand or with a Bar-Lok installation tool. Other cable ties being introduced include a push-mount type with an arrow-head end for mounting in a 1/4-in. hole. Screw-mount versions can be mounted before or after they have been applied to a harness.

Dennison, 300 Howard St., Framingham, MA 01701. (617) 879-0511.

CIRCLE NO. 380

Copper blocks prevent loose connections



Use of hard-drawn copper in a series of power distribution terminal blocks prevents loose connections caused by differing thermal expansion rates. The copper blocks offer greater conductivity than aluminum types and prevent undesirable heat generation and voltage drop. The copper blocks are available with single or dual primary and single or dual secondary connectors, in any combination. Models are also offered with multiple secondary connectors, with provision for four to 12 secondary wire connections. The copper conductor body is electro-tinned. Screws are cadmium-plated to prevent oxidation and to eliminate the need for cleaning before wires are connected. Power block insulators are heat, moisture, solvent and shock-resistant phenolic.

Taylor Electric, P.O. Box 729, Marble Falls, TX 78654. (512) 693-3522.

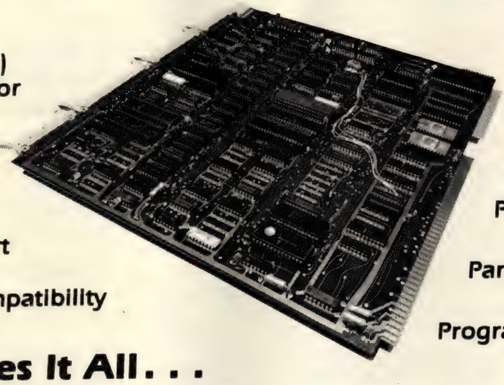
CIRCLE NO. 381

DOSC Introduces

SEE US AT NCC Booth #3419

THE MOST POWERFUL MICROCOMPUTER AVAILABLE TODAY!

TCB-85/
Total Computer Board



48K RAM (64K optional) with sockets available for up to 16K PROM

Strobed or Scanned Keyboard Interface

Serial I/O Port

Intel Multibus™ Compatibility

Dual-Density/Double-Sided Floppy Disk Controller

Programmable CRT Controller

Parallel Printer Interface

Programmable Interrupt Controller

One Board Does It All . . .

Complete as a stand-alone or used with Intel's Multibus™, the TCB-85 combines outstanding performance and reliability with an impressive variety of features. . .all in one compact, low priced package.

In addition to an extremely powerful I/O capability and high level of integration, the TCB-85 is capable of supporting CP/M and PASCAL with DOSC PROMs.

The TCB-85 uses the Intel 8085A CPU and can optionally be ordered with the Intel 8085A-2/10 MHz CPU.

TM Trademark Intel Corporation

Evaluation units are now available for immediate delivery and priced at just $1275 in quantities of 100.

Get All the Details Now!
Contact Alex Newman at (516) 621-6640

DOSC
OEM PRODUCTS DIVISION
175 I.U. Willets Road, Albertson, NY 11507

CIRCLE NO. 195

Core kits make custom chokes and transformers

Hicoil and Hiformer Core Kits contain the basic inductor parts needed to wind magnet-biased choke coils and transformers for a variety of switched-mode power supply applications. Custom designing permits greater production flexibility and shorter turnaround times. The kits are offered in five different core sizes, with each kit containing a ferrite E1 core, magnets, bobbin and chassis mounting or circuit-board mounting brackets. A design information manual is included with specifications and data needed to custom design coils and transformers. Hicoil and Hiformer designs use a magnet biasing technique to obtain chokes and transformers capable of handling higher power than conventional inductors of the same size.

Hitachi Magnetics, Neff Rd., Edmore, MI 48829. (517) 427-5151.

CIRCLE NO. 382

ANTI-STATIC!

Protect delicate integrated systems against static damage.

Static! It's the deadly enemy of sensitive, expensive microelectronic components. Now LEWISystems, a leader in material handling container systems, offers new anti-static products for the electronics industry.

For static-protection in storage and assembly, use LEWISystems "pink poly" DIVIDER® Boxes and Plastibox® Bins. Special holders customize DIVIDER® Boxes to keep circuit boards separate, safe. Plastibox® Bins fit floor-standing or mobile rack assemblies. Material meets requirements for MIL-B-81705B Type II.

LEWISystems manufactures a full line of plastic container systems for material handling, distribution and inventory storage applications.

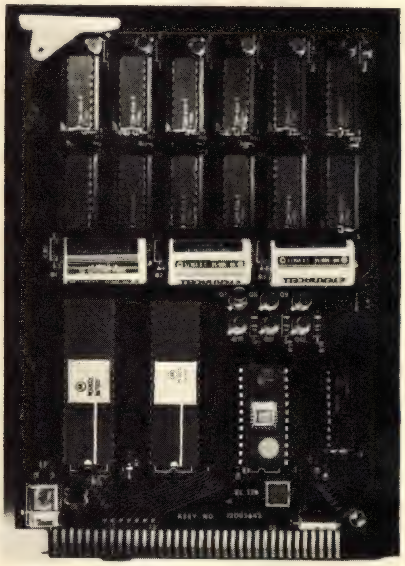
Look to LEWISystems. Write or call for complete information.

LEWISystems®
MENASHA CORPORATION
426 MONTGOMERY ST., WATERTOWN, WI 53094
414/261-3162 • Telex No. 26-9403

LEWISystems PRODUCT SELECTION GUIDE

CIRCLE NO. 202

Plug-in boards expand dicing saw memory

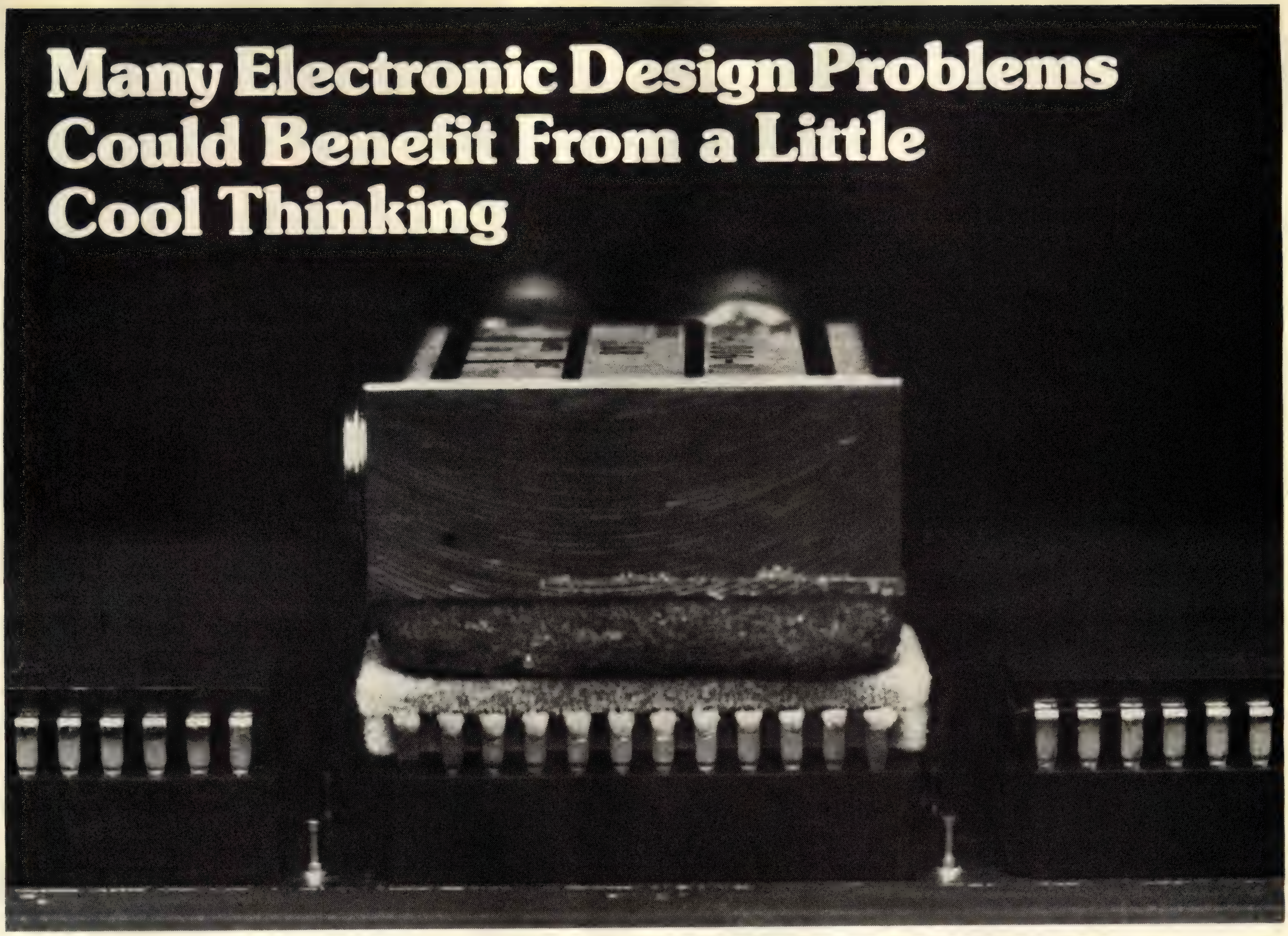


Memory expansion circuit boards, XM060, XM120 and XM180, increase the capacity of the Model 1006 programmable dicing saw. The boards add storage capacity for from 60 to 180 programs and remain totally transparent to the rest of the microprocessor-controlled saw's electronics. The Model 1006 dicing system stores all wafer cutting parameters, including feed speed, external wafer dimensions, die size, mode of operating and other parameters, in either English or metric units.

Micro Automation, 275 Santa Ana Ct., Sunnyvale, CA 94086. (408) 737-1880. $950 (XM060); $1325 (XM120); $1700 (XM180); stock.

CIRCLE NO. 383

Many Electronic Design Problems Could Benefit From a Little Cool Thinking



Herewith are a few modest examples:

Circuit miniaturization:
Often, power dissipation is the limiting parameter in electronic circuit miniaturization. *Solution:* Actively pump the heat out of the circuit package.

Hot environments:
Circuits operating in hot environments overheat and malfunction. *Solution:* Refrigerate these circuits. Cool them to acceptable operating levels.

Noisy, drifting amplifiers:
Amplifiers are noisy at high temperatures and, in some, critical parameters drift, excessively, with temperature change. *Solution:* Regulate amplifier operating temperature to a fixed, cool level.

But design philosophy is not all we have to offer. We have the hardware too. They're called thermoelectric modules. Sandwiched between your circuit package and a suitable heat sink, the thermoelectric module can heat or cool your electronics package and keep it at any preset operating temperature in the range of ambient ±70°C.

Thermoelectric modules are available in a wide variety of shapes and sizes, with or without (air or water) heat sinks, power supplies, or temperature controllers. We also maintain a custom design laboratory where customers bring challenging cooling and temperature regulatory problems everyday.

Let us tell you more about thermoelectric modules and their applications. Call or write for our *new* catalog 300: thermoelectrics.

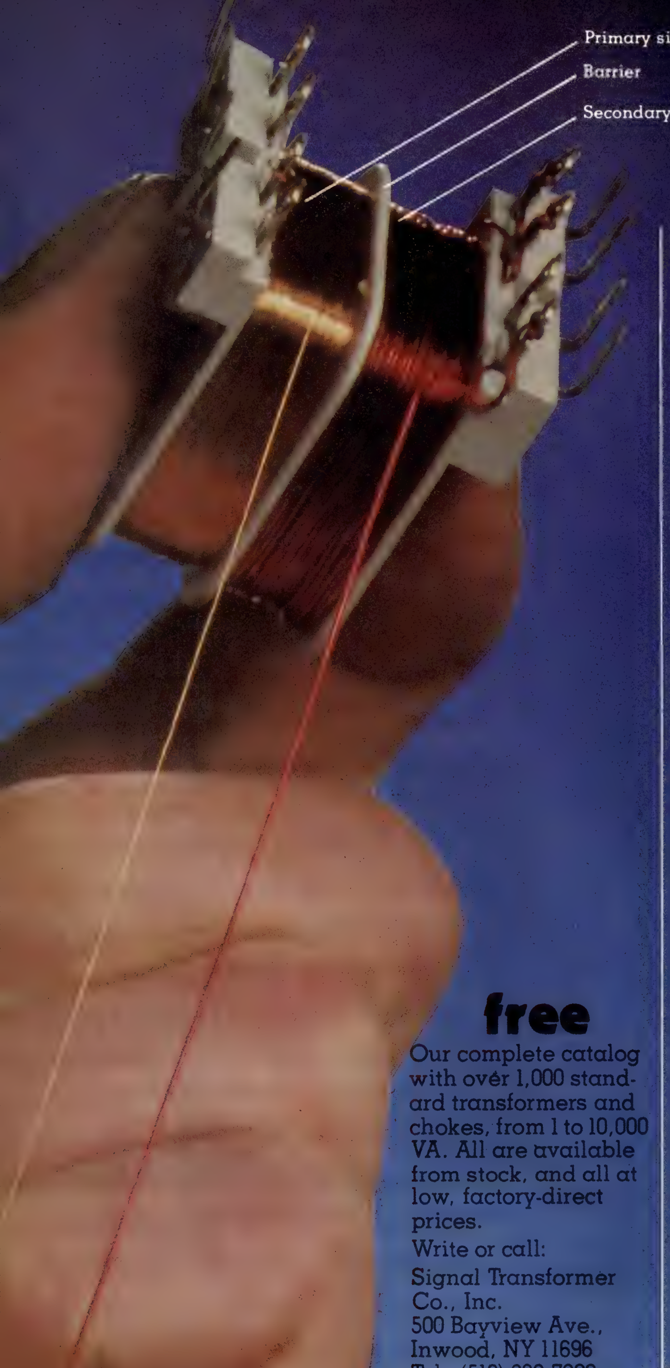
CAMBRIDGE THERMIONIC CORPORATION
CAMBION®
445 CONCORD AVENUE, CAMBRIDGE, MASSACHUSETTS 02238
Telephone (617) 491-5400 TWX (710) 320-6399
TELEX 92-1480 Cable CAMBION

Visit Cambion at Electro '80 Booth #2028

West coast office: Cambridge Thermionic Corporation, 2733 Pacific Coast Highway, Suite 308, Torrence, Cal. 90505 Tel. (213) 326-7822, 7823, 7824

CIRCLE NO. 197

Split Personality.



Recognized Component
Underwriters Laboratories, Inc

Our ingenious split bobbin transformer design gives you high isolation . . . at low cost.

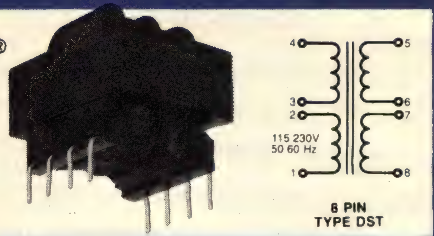
Ordinary transformers have to be shielded to get high isolation. Our transformers are different . . . and better. By separating the primary from the secondary windings — through our split bobbin design — we achieve high isolation at lower cost. That's what you should expect from the world leader in off-the-shelf transformers and chokes. And that's why thousands of companies swear by Signal for quality, value and complete satisfaction. Wide choice of secondary outputs available on all types.

PRONTO DELIVERY

We ship your prototypes in 48 hours. These three distinct, hard-working personalities are always available for *Pronto* delivery.

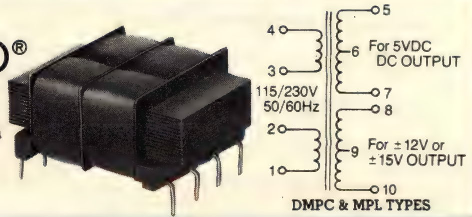
SPLIT/TRAN®

2500 V RMS HIPOT.
Non-concentric windings and low capacitive coupling. Available with 115V or dual 115/230V primaries. Split secondary windings can be series or parallel connected.



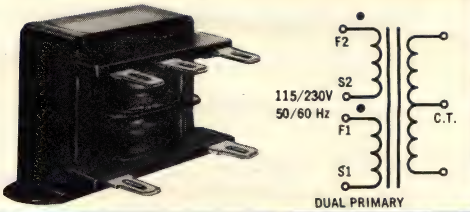
FLATHEAD®

For optimum powering of 1" space PC boards. Delivers 6 VA in less than .085" height.
(Semi-Toroidal windings.)



2-4-1®

2500 V RMS HIPOT.
The signal for a 50% cut in transformer size & weight at significantly less cost.



free

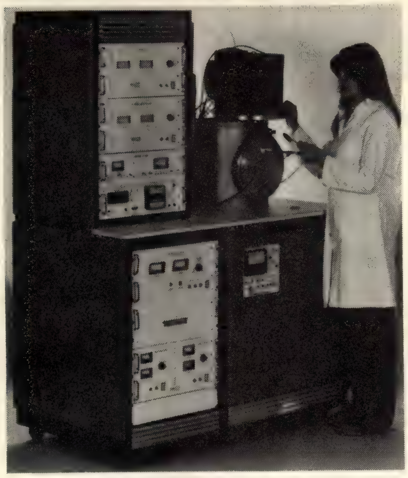
Our complete catalog with over 1,000 standard transformers and chokes, from 1 to 10,000 VA. All are available from stock, and all at low, factory-direct prices.

Write or call:
Signal Transformer Co., Inc.
500 Bayview Ave.,
Inwood, NY 11696
Tel.: (516) 239-7200
Or (516) 239-4510

signal
TRANSFORMER

CIRCLE NO. 198

Ion mill etches and deposits on thin-film



An ion-beam system, MIM-TLA 12.5, etches and deposits on thin-film substrates. Milling is performed by accelerating a collimated beam of ions towards the substrate. The resulting anisotropic or unidirectional milling provides superior control and quality as compared to wet-chemical methods. The system is capable of etching sub-micron lines with precise control over wall angle, and with depth-to-width ratios as high as 10:1. A 12.5-cm beam is produced with a uniformity of ±2% over the center 10 cm and ±5% over the entire beam. An ion beam of either argon or various reactive gases provides improved milling rate selectivity. Ion-beam sputtering is performed by milling the material to be deposited, directing the resulting sputtered material towards the substrate to be coated. Deposition takes place in a vacuum of better than 1×10^{-4} torr. As many as four different materials can be deposited on a substrate in-situ without breaking vacuum.

Technics IMF, 7950 Cluny Ct., Springfield, VA 22153. (703) 569-7200.

CIRCLE NO. 384

Force gauge tests wrap-wire connections

A hand-held tester, TW, measures the gripping strength of wrapped-wire connections. The device aids evaluation and monitoring of wrap-wiring equipment. The force gauge is equipped with a special fixture which quickly pulls wire wraps from terminal posts and records the force exerted. The fixture is actuated by a hand lever, permitting tests to be performed rapidly and easily with one hand. The device is spring-loaded and automatically returns to position for the next test. A variety of ranges is available, from 0 to 500 g to 0 to 30 lb. Displays can be calibrated in grams, ounces, kilograms, pounds and Newtons.

Ametek Hunter Spring, One Spring Ave., Hatfield, PA 19440. (215) 822-2971.

CIRCLE NO. 385

CAMBION IC SOCKETRY.

Now as a boon to design engineers, production and QC specialists—and everyone else concerned with loaded PC board performances—Cambion offers TWO great series of LOW PROFILE solder-tab IC sockets: the *new* nylon body *703-53XX* Series and the *newest* polyester body *703-42XX* Series (UL 94V-0 rated).

Both super-dependable series feature an inverted contact design for excellent lead-in and secure gripping of the flat sides of delicate DIP leads (face-wipe). *Both* series offer anti-moisture bosses and Kapton® anti-wicking sealing strips. Cambion helps—all across the (PC) board—check out the chart for fast, easy reference, and keep your PO's handy!

CLIP AND SAVE

CAMBION LOW-PROFILE IC SOCKETS

Solder-Tab[1], Electrotin Finish[2], Kapton® seal

Total No. Pins	Centers	Body Length	**Series 703-53XX** Red Nylon Body Cambion Part No.	**Series 703-42XX*** Black Polyester Body For Automatic IC Insertion Cambion Part No.
8	.300	.396	703-5308-01-04-12	703-4208-01-04-10
14	.300	.696	703-5314-01-04-12	703-4214-01-04-10
16	.300	.796	703-5316-01-04-12	703-4216-01-04-10
18	.300	.896	703-5318-01-04-12	703-4218-01-04-10
20	.300	.996	—	703-4220-01-04-10
22	.400	1.096	703-5322-01-04-12	703-4222-01-04-10
24	.600	1.196	703-5324-01-04-12	703-4224-01-04-10
28	.600	1.396	703-5328-01-04-12	703-4228-01-04-10
40	.600	1.996	703-5340-01-04-12	703-4240-01-04-10
64	.900	3.196	703-5364-01-04-12	—

Get our new IC Socket Catalog!

[1] *Mounting Data: Drill no. 67, mtg. hole dia is .032"*

[2] For gold finish, specify -03 instead of -04

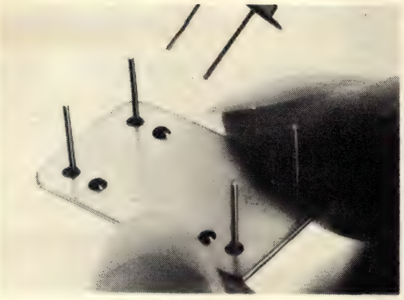
*Open ended for air circulation and easy access for removal of DIP.

CAMBION®
The Right Connection.

Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, MA 02238
Tel: (617) 491-5400, Telex: 92-1480, TWX: (710) 320-6399

CIRCLE NO. 199

Integral standoffs keep hybrid off boards

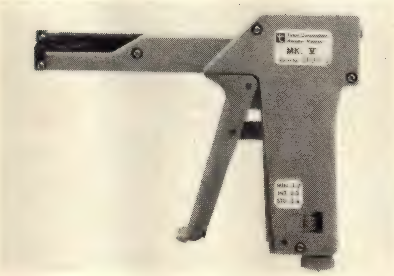


Integral glass standoffs eliminate the need for separate insulation on a 4-pin DIP hybrid-circuit header. Molded glass standoffs, formed during manufacture, provide both board clearance and insulation. Nominal PC-board clearance is 0.02 in. The header will be available in 4 to 24-pin sizes.

Reeves-Hoffman, 400 W. North St., Carlisle, PA 17013. (717) 243-5929.

CIRCLE NO. 386

Lightweight hand tool attaches cable ties

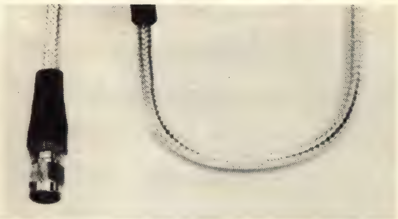


A lightweight hand tool, Mark V, attaches cable ties. The tool weighs only 8-1/2 oz for greater operator comfort. The casing is made from polycarbonate material for durability.

Tyton, 7930 N. Faulkner Rd., Milwaukee, WI 53223. (414) 335-1130.

CIRCLE NO. 387

Flexible cable carries rf with low loss



Stripflex-II, low-loss, flexible cable asssemblies, maintain performance specification from 2 to 18 GHz. Three cable sizes are offered: 0.125, 0.18 and 0.25 in. The assemblies can replace 0.141-in. hardline in many applications. Loss is 38 dB/100 ft at 18 GHz. Typical specifications for a 1-ft length of 0.25-in. cable are a VSWR of 1.35, maximum power capacity of 100 W and an insertion loss of 0.38 dB.

Times Wire & Cable, 358 Hall Ave., Wallingford, CT 06492. (203) 265-8500.

CIRCLE NO. 388

TCXO
Compact and Reliable
CRYSTAL OSCILLATOR

Series TCO-500
for FREQUENCY
STANDARD

TCO-501 (Size: mm)

- FREQUENCY STABILITY

- SPECIFICATIONS

Frequency: 5～25MHz
Stability: ±1ppm −10～+60°C ±5ppm −20～+70°C
Aging: ±1ppm/year

Series TCO-900
for VHF/UHF mobile,
portable FM Radio

TCO-904 (Size: mm)

- FREQUENCY STABILITY

- SPECIFICATIONS

Frequency: 10～80MHz
Stability: ±3～5ppm −30～+60°C
Aging: ±1ppm/year

TOYO COMMUNICATION EQUIPMENT CO., LTD.
No.8 Mori Bldg., 20-4, Nishi-Shimbashi 3-chome, Minato-ku, Tokyo 105, Japan
Phone: 03-436-2180 Telex: 02423115 TOYOCO J

In U.S.A., Please Contact
TOYOCOM U.S.A. Inc. Suite 364, 350 South Figueroa St.
Los Angeles, California 90071 U.S.A.
Phone: (213) 626-6822 Telex: 688455 TOYOCOM LSA

CIRCLE NO. 200

COMPUTER BOOKS THAT TALK YOUR LANGUAGE . . . FROM BEGINNER TO EXPERT.

Howard W. Sams is the source for the best and latest in computer technology. The world's leading authors. Clear, concise, easy-to-understand text. Fully illustrated for better comprehension. Actual programs for today,s personal computers. Informative and entertaining. Titles for everyone . . . from the novice to the hobbyist to the expert.

THE STARTERS

Entry-level books for the beginner can bring the novice up to a high level of knowledge quickly.

☐ **THE HOWARD W. SAMS CRASH COURSE IN MICROCOMPUTERS**
The short-cut to understand microcomputers. Spend a few hours with this self-instructional course and gain a working knowledge of all aspects of microcomputers from fundamentals to operating systems, programming, peripheral equipment and much, much more. 264 pages. No. 21634. By Frenzel. $17.50.

☐ **MICROCOMPUTERS FOR BUSINESS APPLICATIONS**
A microcomputer expert discusses the benefits of microcomputer systems for small business owners. Explains types of microcomputers available, points out pitfalls to avoid, and defines computer-related terms in easy-to-understand language. 256 pages. By Barden. No. 21583. $8.95.

☐ **A GUIDEBOOK TO SMALL COMPUTERS**
If you are contemplating buying a small computer system for home or business, this book can save you time and trouble. Covers fundamentals of small computers including hardware and software. Includes information on manufacturers' warranties, service and a handy directory of small computer manufacturers. By Barden. No. 21698. $5.95.

☐ **GETTING ACQUAINTED WITH MICROCOMPUTERS**
Provides a complete working knowledge of microcomputer organization, operation, and programming. 288 pages. By Frenzel. No. 21486. $8.95

☐ **FUNDAMENTALS OF DIGITAL COMPUTERS (2nd ED.)**
Unravels the mysteries of computers and programming. 320 pages. By Spencer. No. 21534. $9.95.

☐ **INTRODUCTION TO MICROCOMPUTERS FOR THE HAM SHACK**
Gives the radio amateur an opportunity to be in the forefront of utilizing and developing techniques in "computercations." 96 pages. By Helms. No. 21681. $4.95.

LEARN ABOUT MICROCOMPUTERS, SAVE 10% . . . AND GET A FREE GIFT!

☐ **THE COMPUTER PRIMER LIBRARY**
This 3-volume "starter" library was selected for the novice who wants to learn about microcomputers. Concepts. Programming. Computer graphics. Languages. Games. By Mitchell Waite and Michael Pardee—two of the leading authors in the field of computers.

MICROCOMPUTER PRIMER—368 pages of up-to-date facts on microcomputers and computer concept.

COMPUTER GRAPHICS PRIMER—Over 20 programs for creating your own video graphics (complex drawings, plans, maps, and schematics) on the new 6502-based personal computers.

BASIC PROGRAMMING PRIMER—Provides a working knowledge of BASIC, the most popular computer language today. Explains fundamentals, of BASIC, program control, organization, additional functions, variations, and includes a game program.

3-VOLUME LIBRARY PACKAGE ONLY $30.47—includes a FREE COPY of YOUR OWN COMPUTER—an introduction to home computers. No. 21706

THE PROGRAMMERS

A computer is only as good as the software. Sams offers several books that explain programming and tell you how to develop, debug and test programs for your equipment.

☐ **PROGRAMMING & INTERFACING THE 6502, WITH EXPERIMENTS**
Dr. De Jong has compiled 14 chapters of information and programs for 6502-based microcomputer systems. Experiments and examples are written so that a KIM, AIM or SYM system may be used to reinforce the material in each chapter. 448 pages. By De Jong. No. 21651. $11.95.

☐ **HOW TO PROGRAM AND INTERFACE THE 6800**
Discusses the internal structure, instruction set, and programming techniques for the 6800. Experiments demonstrate "real world" applications. By Staugaard. 432 pages. No. 21684. $13.95.

☐ **DBUG: AN 8080 INTERPRETIVE DEBUGGER**
Covers program operation and how it's applied to program development and testing. 112 pages. By Titus and Titus. No. 21536. $4.95.

☐ **6502 SOFTWARE DESIGN**
Tells how to program for the 6502 assembly language. 288 pages. By Scanlon. No. 21656. $10.50.

☐ **8080/8085 SOFTWARE DESIGN—2 VOLUMES**

☐ VOLUME 1 gives you an introduction to assembly language programming. 336 pages. By Titus, Larsen, Rony, & Titus. No. 21541. $9.50

☐ VOLUME 2 is a unique, one-of-a-kind computer science book for the design engineer. Written in Intel machine code. 352 pages. By Titus, Larsen, & Titus. No. 21615. $9.95.

☐ TWO-VOLUME SET No. 21659 ONLY $17.50

☐ **TEA: AN 8080/8085 CO-RESIDENT EDITOR-ASSEMBLER.**
256 pages. No. 21628. By Titus. $8.95.

THE COMPUTER TECHNOLOGY LEADERS

Even if you're an avid computer buff, rapidly changing technology makes it difficult to stay current. Sams has a complete line of books and reference publications to help you keep abreast of the current state-of-the-art.

☐ **MICROCOMPUTER-ANALOG CONVERTER SOFTWARE & HARDWARE INTERFACING.**
Concepts and techniques of interfacing digital computers to analog devices. 288 pages. By Titus, Titus, Rony, & Larsen. No. 21540. $9.50.

☐ **TRS-80 INTERFACING.**
192 pages. No. 21633. By Titus. $8.95.

☐ **INTERFACING & SCIENTIFIC DATA COMMUNICATIONS EXPERIMENTS.**
160 pages. By Rony, Larsen, Titus, &Titus. No. 21546. $5.95.

☐ **MICROCOMPUTER INTERFACING WITH THE 8255 PPI CHIP.**
224 pages. By Goldsbrough. No. 21614. $8.95.

☐ **Z-80 MICROPROCESSOR PROGRAMMING & INTERFACING—2 VOLUMES.**
800 pages. By Nichols, Nichols, & Rony. No. 21611. $21.95.

☐ **INTRODUCTORY EXPERIMENTS IN DIGITAL ELECTRONICS AND 8080A MICROCOMPUTER PROGRAMMING AND INTERFACING—2 VOLUMES.**
912 pages. By Rony, Larsen, & Titus. No. 21552. $20.95.

A BEST-SELLER . . . A TREMENDOUS VALUE!

This is the most comprehensive reference available on all phases of computers and their applications. Contains over 22,000 definitions, acronyms, and abbreviations. 14 appendices. Hardbound. 944 pages. By Sippl & Sippl. No. 21632. $29.95.

☐ **COMPUTER DICTIONARY & HANDBOOK (3RD EDITION)**

THE LOGIC COOKBOOKS

☐ **LANCASTER'S COOKBOOK LIBRARY**
A famous resource for all electonics buffs who want to know what makes TTLs, CMOS, and active filters cook—what they are, how they work and how to use them. By Don Lancaster, one of the most popular authors in the electronics industry.

TTL Cookbook No. 21035	$ 9.50
CMOS Cookbook No. 21398	$10.50
Active-Filter Cookbook No. 21168	$14.95
TOTAL LIST PRICE	$34.95
Less 15% Discount	5.24
YOU PAY ONLY	$29.71

☐ **ORDER SPECIAL LIBRARY PACKAGE NO. 21707 AND SAVE!**

ORDER FORM

HOWARD W. SAMS & CO., INC.
4300 West 62nd Street, P.O. Box 7092
Indianapolis, Indiana 46206
(317) 298-5400

Indicate quantity in boxes above and complete ordering information below.

Sub Total________________

Add local sales tax where applicable________

GRAND TOTAL________________

☐ PAYMENT ENCLOSED
☐ CHECK ☐ MONEY ORDER
☐ MASTER CHARGE ☐ BANK AMERICARD/VISA

Exp. Date________________

Account No.________________

Interbank No. (Master Charge only)________
Minimum Credit card purchase $10 AD010

Name (print)________________

Signature________________

Address________________

City________ State________ Zip________

Prices subject to change without notice. All books available from Sams Distributors, Bookstores, and Computer Stores. Offer good in U.S. only. In Canada, contact Lenbrook Industries Ltd., Scarborough, M1H 1H5, Ontario, Canada.

Howard W. Sams & Co., Inc.

CIRCLE NO. 201

New Literature

Data converters

Data conversion products are covered in a four-page catalog. Phoenix Data, Phoenix, AZ

CIRCLE NO. 408

Sonic digitizer

The Model GP-359 sonic digitizer, used with Texas Instruments SR-59 handheld programmable calculators, is covered in a two-page bulletin. Specifications are provided, along with descriptions of stylus, cursor and sensor assemblies. Science Accessories, Southport, CT **CIRCLE NO. 409**

High-power rectifiers

Two high-power rectifier series, with average forward current ratings of 2600 and 3000 A in the Hockey Puk package, are described in a data sheet. International Rectifier, Semiconductor Div., El Segundo, CA

CIRCLE NO. 410

Swept measurement system

Specifications and system component information on the Model 1038 swept frequency measurement system are given in a four-page catalog. Pacific Measurements, Sunnyvale, CA

CIRCLE NO. 411

Relays

Over 518 relays are described in a catalog. Contacts are rated from 10 to 50 A at 28 V dc or 115/220 V ac. Magnecraft Electric, Chicago, IL

CIRCLE NO. 412

Industrial control relays

Specifications and schematic diagrams for control relays are given in a 52-page catalog. Terminals, contact current ratings, contact configurations and input ratings and features are specified. Eagle Signal Industrial Controls, Davenport, IA

CIRCLE NO. 413

Heat sinks

Descriptions, photos and dimensional diagrams of heat sinks are given in a 48-page catalog. Aavid Engineering, Laconia, NH

CIRCLE NO. 414

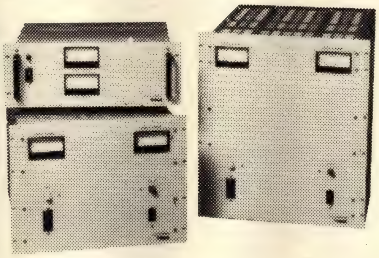
Coaxial switches

An extended line of coaxial switches is featured in a catalog. Micronetics, Norwood, NJ

CIRCLE NO. 415

TOPAZ
POWERMARK DIV.

- **Sine Wave Inverters**
- **Frequency Converters**



Inverters

OUTPUT VA	PRODUCT SERIES	INPUT VOLTAGE	OUTPUT VOLTAGE
50 Hz Output Inverters, Single-phase			
200	GZ	12/24,28,48 or 125	115/230
400	GZ	12/24,28,48 or 125	115/230
800	GZ	12/24,28,48 or 125	115/230
1,600	GZ	12/24 or 28	115/230
2,000	GX	48 or 125	115 or 230
2,400	GZ	12/24 or 28	115/230
4,000	GX	48 or 125	115 or 230
8,000	GX	125 or 250	115 or 230
60 Hz Output Inverters, Single-phase			
250	GZ	12/24,28,48 or 125	115
500	GZ	12/24,28,48 or 125	115
1,000	GZ	12/24,28,48,125 or 250	115 or 115/230
2,000	GZ	12/24 or 28	115 or 115/230
2,500	GX	48 or 125	115 or 230
3,000	GZ	12/24 or 28	115 or 115/230
5,000	GX	48 or 125	115 or 230
10,000	GX	125 or 250	115 or 230
400 Hz Output Inverters, Single-phase			
250	GZ	12/24 or 28	115
500	GZ	12/24 or 28	115
1,000	GZ	12/24 or 28	115
2,000	GZ	12/24 or 28	115
2,500	GX	125	115

Frequency Converters

OUTPUT VA	PRODUCT SERIES	INPUT VOLTAGE	OUTPUT VOLTAGE
50 Hz Output Frequency Converters, Single-phase			
200	FZ	115	115/230
200	FZ	230	115/230
400	FZ	115	115/230
400	FZ	230	115/230
800	FZ	115	115/230
800	FZ	230	115/230
1,600	FZ	115	115/230
1,600	FZ	230	115/230
2,000	FX	115,208,230 or 240	115 or 230
4,000	FX	115,208,230 or 240	115 or 230
8,000	FX	115,208,230 or 240	115 or 230
60 Hz Output Frequency Converters, Single-Phase			
250	FZ	115	115
250	FZ	230	115
500	FZ	115	115
500	FZ	230	115
1,000	FZ	115	115 or 115/230
1,000	FZ	230	115 or 115/230
2,000	FZ	115	115 or 115/230
2,000	FZ	230	115 or 115/230
2,500	FX	115,208,230 or 240	115 or 230
5,000	FX	115,208,230 or 240	115 or 230
10,000	FX	115,208,230 or 240	115 or 230

FEATURES

Proven Reliability
Rugged Construction
Excellent Stability
Input/Output Protection
Design Simplicity
High Efficiency

Optional Features

- Precision frequency control
- External frequency synchronization
- Voltage and current meters
- Static transfer switches

General Specifications

Frequency Stability: ±0.5% of fixed frequency. ±0.01% optional

Output Protection: Overload and short circuit

Input Protection: High and low voltage reverse polarity.

Total Harmonic Distortion: Less than 5% at full load and nominal line

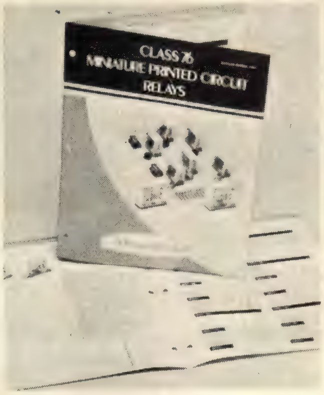
Operating Temperature: −10°C to +55°C

Inverter Efficiency: Typical 75% at full load

Input Frequency Ranges: Typically 45 to 500 Hz

TOPAZ POWERMARK DIVISION
5577 KEARNY VILLA ROAD, SAN DIEGO, CALIFORNIA 92123
PHONE [714] 565-8363

CIRCLE NO. 196



Miniature PC relays

General-purpose, high-current Class 76 miniature PC-mount relays, from 2 to 10 A, are featured in a catalog. Magnecraft Electric, Chicago, IL **CIRCLE NO. 416**

HV components

A 19-page catalog covers high-voltage components for ac, dc and rf applications. ITT Jennings, San Jose, CA **CIRCLE NO. 417**

8 × 8-bit multiplier

A block diagram of a high-speed 8 × 8-bit multiplier, equivalent I/O schematics, specs and a glossary of terms are included in an eight-page data sheet. TRW LSI Products, El Segundo, CA

CIRCLE NO. 418

Touch screen digitizers

Specifications, applications and principles of operation of 12 and 15-in. touch screen digitizers are given in a six-page brochure. TSD Display Products, Bohemia, NY

CIRCLE NO. 419

Proximity systems

A 53-page bulletin describes WE-77 control amplifiers. The bulletin includes functional drawings and circuit diagrams. Gould R.B. Denison, Bedford, OH

CIRCLE NO. 420

Strippers, brushes

Rush production wire strippers, Wybar component lead formers and Power Brush industrial brushes are featured in a four-page brochure. The Eraser Co., Syracuse, NY

CIRCLE NO. 421

Instrumentation recorders

Specifications on the IRIG-compatible Series SE3000 portable instrumentation recorders are detailed in a four-page brochure. EMI Technology, Stamford, CT

CIRCLE NO. 422

Dc power supplies

Dc power supplies, including 23 new models, are presented in a 28-page catalog. Outline and mounting diagrams are included. Power-One, Camarillo, CA

CIRCLE NO. 423

STANDBY POWER

for Mini Computers & Micro Processors

Don't lose valuable memory or programming from your mini computers and micro processors when there's a power outage.

Plug in Welco standby power supplies have transfer delay of less than 25 milliseconds max to regulated 120 VAC from sealed gell battery for orderly shut down. No maintenance.

SPS 250 delivers 2.1 amps max; SPS 500 supplies 4.2 amps max. One year warranty on each unit.

Call or write today for details.

WELCO
INDUSTRIES, INC.
9027 Shell Rd.
Cincinnati, Ohio 45236
Phone: (513) 891-6600

CIRCLE NO. 203

CUBIT INTRODUCES

AIM-65 PROGRAMMING POWER

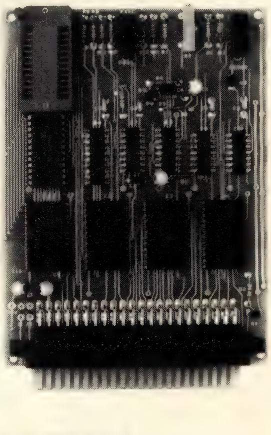
THE EPROM PROGRAMMER DESIGNED EXCLUSIVELY FOR THE AIM-65

'Zero Insertion Force Socket' for EPROM programming

'Powerful Monitor' contains all programming routines.

'EPROM Expansion' for 8K of user programmed EPROM.

'Female Connector plugs directly onto the AIM-65 expansion bus. Male connector plugs into motherboards.

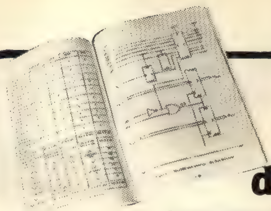


For more information on AIM-65 programming power call or write:

(415) 962-8237
CUBIT 2267 Old Middlefield Way
Mountain View, CA 94043

AIM-65 is a trademark of Rockwell International Corporation

CIRCLE NO. 204



$20 buys you $30,000 of design research!

Introducing NBUS — compatible with all popular 16-bit microprocessors!

In-depth 10,000 word report details this revolutionary bus design. 23 figures, interface designs and timing for 8086, 8000, 68000 and 9900 microprocessors show you how to incorporate this exciting structure into your system.

- COMPACT 56 pin connector, 4 1/2" card width
- POWERFUL 16 megabyte address space
- VERSATILE multiprocessor master/slave protocol

NEW 64K byte RAM Memory Board available June 1980. NBUS compatible. Self-contained refresh capability. Limited production — orders filled in order of receipt. Reserve now. $1,300.

☐ Please send **NBUS REPORT.** $20* check or M/O enclosed.
☐ Reserve ____ (quantity) **Memory Board(s)** — delivery June 1980.
☐ $1,300* check or M/O enclosed ☐ P.O. # ________ enclosed.

*Postage included. Mass residents add 5% sales tax.

Name ________ Position ________
Company ________
Address ________
City ________ State ________ Zip ________

Mail to:
NUVEC LABORATORIES, INC. • Dept. ED • 15 Glenridge Dr.
Bedford, MA 01730

CIRCLE NO. 205

BRUSHLESS DC MOTORS

Because they have no brushes or commutators as do ordinary DC motors, Canon's brushless motors are virtually free of electrical noise and have a very long reliable and maintenance free service life . . . limited only by the motor's bearing life. Mechanical noise is also very low. High quality electronic speed control circuitry provides extraordinary stability over wide torque, voltage and temperature ranges.

Model	Rated Voltage (V)	Rated Speed (rpm)	Rated Load (g-cm)	Rated Current (mA)	Starting Torque (g-cm)	Stall Current (A)	Voltage Range (V)	Weight (g)
BZ 43-T1N1C	12	2000	50	330	95	2.0	10.8 to 13.2	230
BW 52-H1N1	24	2000	150	500	330	2.0	21.6 to 26.4	500

For complete technical information:

Canon

Canon U.S.A., Inc.
Electronic Components Division
10 Nevada Drive,
Lake Success, L.I., N.Y. 11042
Tel. (516) 488-6700
Telex 96-1333
Cable - Canon USA LAKS

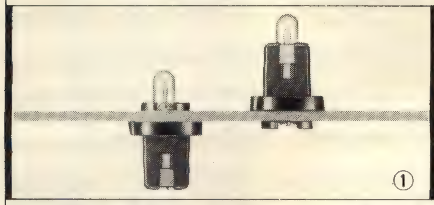
CIRCLE NO. 207

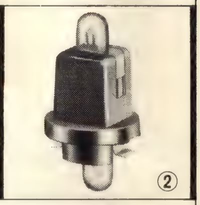
OSHINO

OL The Mark You Can Trust

New PBB LAMP

Bayonet Base Subminiature Lamp
Directly Replaceable on P.C. Board


①


②

No soldering or socket required.
Just insert and turn 90 deg. to mount.

1. Mountable to either side of P.C. Board. (Photo ①)
2. Bulb can be provided on either, or both ends on request. (Photo ②)

• For detailed literature and sample, call or write:

WAMCO Technical Sales, Inc.
705 W. 16th Street, Costa Mesa, California 92627 TEL: (714) 833-9361
TELEX: 678459

OSHINO ELECTRIC LAMP WORKS, LTD.
Shinagawa, Tokyo, Japan

CIRCLE NO. 206

New Pressure Transducer Catalog

If you measure pressure, you'll want this condensed catalog. It describes a wide range of pressure transducers and related instruments. All units are built to exacting quality standards for reliable, trouble-free operation in the toughest environments. And at prices you have to like. Send for catalog of stock models.

DATA INSTRUMENTS INC.

4 Hartwell Place, Lexington, Mass. 02173
617-861-7450 TWX 710-326-0672

CIRCLE NO. 208

FAPE engineers end their first strike. . .

By a vote of 74 for, 23 against, engineers in the Florida Association of Professional Employees (FAPE) have ratified a three-year contract with Boeing Services International (BSI). The FAPE engineers had been on strike against BSI since Feb. 13, but few of the prestrike demands were granted by the settlement on March 10.

Contract talks originally broke down because BSI refused to include cost-of-living adjustments and other benefits in the negotiations (see ELECTRONIC DESIGN, April 12, p. 273). The COLA demand was not met by the final contract.

The most significant change brought about by the strike was a redistribution of the 9%-8%-8% wage increase over the three-year contract period. For example, instead of a 5% increase and a 4% selective adjustment pool in the first year, the distribution will now be a 7% general increase and a 2% pool for correcting salary inequities. But the total money available for all wage increases remains the same as before the strike.

Another important gain for FAPE involves severence pay. In the event of a layoff, BSI engineers are now contractually entitled to one week of severence pay for each year of service, up to a maximum of six weeks pay.

...as organizing gathers momentum

The Seattle Professional Engineering Employees Association has filed a petition with the National Labor Relations Board, requesting an election among the professional payroll employees at Boeing's Vertol Division (Philadelphia, PA). Engineers at Boeing Vertol had requested the Association's help and leadership in a grassroots effort to set up a collective bargaining unit.

Collective bargaining will become a reality at Vertol if 50% + 1 of those voting in the election favor union representation. The election results will affect about 700 people.

At this report, signatures on the authorization cards are in the process of official verification. No date has been announced for the requested NLRB election.

Carter to scrutinize engineering education

President Carter wants to know if current science and engineering education policies can meet future manpower needs. On February 8, he issued a memo to Secretary of Education Shirley Hufstedler and National Science Foundation director Richard C. Atkinson, stating: "I am increasingly concerned whether our science and engineering education is adequate, both in quality and number of graduates, for our long-term needs. Accordingly I would like you to carry out a review of our science and engineering education policies at the secondary and university levels to ensure that we are taking measures which will preserve our national strength. Please submit a report to me, with your recommendations, by July 1, 1980."

As a result, the NSF has sent letters to approximately 40 organizations, including the IEEE, asking for material that might be included in the report.

Respondents will be providing answers to four open-ended questions:

- How should a science/engineering national-needs study be conducted?
- Are there potential problems in availability of scientists and engineers in specific fields?
- What technology trends have you noted that would affect future training needs?
- What are the short and long-term goals for science and engineering education?

Though the NSF requested a response by April 7, few inputs were expected—or received—by that date.

In the past, government studies of technical manpower needs have aggravated, rather than helped, the employment picture because of inaccurate prediction of engineering shortages.

Engineers brief politcos on pensions and energy

During this Presidential election year, IEEE is making sure that topics of importance to engineers will appear on the national agenda. The Institute has been tutoring Republicans and Democrats alike on pension reform, energy and innovation at the 1980 platform hearings of each party.

Already the IEEE's attitudes on pensions and innovation have been presented to Republicans in Indianapolis, IN. Democrats in Seattle, WA, have heard the Institute's comments on pensions. During June, in Washington, DC, the Republicans will receive testimony on energy policy; and the Democrats, testimony on innovation and energy both.

Final political platform hearings for both parties will be held during the summer, and IEEE expects to field an invited representative. The National Society of Professional Engineers has also been active recently, providing both parties with information on subjects affecting its members.

Don Mennie

Electronic Design

recruitment and classified ads

PLACE YOUR AD AT ONLY $65 PER COLUMN INCH IN

Electronic Design

YOU REACH ENGINEERS WITH TITLES LIKE THESE:

• Chief Engineer • Development Engineer • Design Engineer • Project Engineer • Electronic Engineer • Engineer-Supervisor • Section Leader • Staff Engineer • Systems Engineer • Test Engineer • Standards Engineer • Master Engineer

Total Qualified and Paid 112,000

Electronic Design RECRUITMENT ADVERTISING RATES

15% commission to recognized agencies supplying offset film negatives. 2% 10 days, net 30 days. Four column makeup. Column width 1-3/4" x 10"

SPACE	DIMENSIONS Wide	Deep	COST
*One column inch	1-3/4"	x 1"	$65.
1/8 page (1/2 col.)	1-3/4"	x 5"	$322.
1/4 page (1 col.)	1-3/4" 3-1/2"	x 10" Vert. x 5" Hor.	$644.
1/2 page (2 cols.)	3-1/2" 7"	x 10" Vert. x 5" Hor.	$1,287.
3/4 page (3 cols.)	5-1/4"	x 10"	$1,931.
1 page	7"	x 10"	$2,574.

REVISED RECRUITMENT & CLASSIFIED RATES

	1X	4X	7X	13X	19X	26X	39X	52X
*Per Column Inch	$65	$63	$59	$54	$52	$50	$49	$48

LATE CLOSING DATES

Electronic Design is mailed every two weeks. Because of its timeliness, personnel recruitment advertising closes only two weeks before each issue's mailing date.

Issue Date	Closing Date	Mailing Date
May 24	April 25	May 9
June 7	May 9	May 23
June 21	May 23	June 6
July 5	June 6	June 20
July 19	June 20	July 7
August 2	July 3	July 18

HOW TO PLACE YOUR AD

CALL THE RECRUITMENT
HOT LINE 201-843-0550
TELECOPIER EXT. 212

Camera-ready film (right reading negatives, emulsion side down) or camera-ready mechanicals must be received by deadline. Or, if you wish us to set your ad (typesetting is free) simply pick up the phone and call our RECRUITMENT HOT LINE – (201) 843-0550. Ask for:

Roberta Renard
RECRUITMENT ADVERTISING MANAGER
ELECTRONIC DESIGN
50 Essex Street, Rochelle Park, New Jersey 07662

ELECTRONICS ENGINEERS

CHALLENGING CIVIL SERVICE POSITIONS AT

ROBINS
AIR FORCE BASE
GEORGIA

IN THE FOLLOWING AREAS:

- ELECTRONIC WARFARE SYSTEMS
- RADAR SYSTEMS
- COMPUTER CONTROLLED WEAPONS SYSTEMS
- DIGITAL AVIONICS SYSTEMS
- AUTOMATIC TEST EQUIPMENT
- OPERATIONAL FLIGHT PROGRAMS
- COMMUNICATION-NAVIGATION SYSTEMS

Robins AFB is Georgia's largest employer and borders Warner Robins, Georgia. Middle Georgia offers high quality living at a moderate cost. It is an ideal location for a variety of outdoor activities with an average temperature of 65 degrees and an average yearly rainfall of 46.3 inches. Nearby facilities provide for fishing, hunting, golf, tennis, boating, and other leisure activities. With Atlanta just 100 miles to the north, professional sports and "big city" civic and cultural events are within easy reach. Salary range: $14,618 to $24,703. Excellent fringe benefits including relocation assistance. Applicants should have a degree or be a registered PE and be a U. S. citizen. All qualified applicants will receive consideration without regard to race, color, sex, national origin, age, marital status, nondisqualifying physical handicap, or political affiliation. Reply in confidence to: Warner Robins Air Logistics Center/DPCSC, Robins AFB, GA. 31098. Phone (912) 926-5711 or 5821.

ELECTRONIC RESEARCH ENGINEER

The Trane Company is looking for an Electronic Research Engineer for our corporate research group.

Responsibilities will include project participation in high frequency digital communications associated with systems and components of energy management facilities. Technical tasks include the design, analysis and application of electronics common to communications systems and instrumentation incorporating state of the art technology.

This position requires a MS in electrical engineering and at least one year of experience designing communications systems for digital data transmission.

The Trane Company is a leading manufacturer of HVAC products. Our corporate headquarters are located in La Crosse, Wisconsin, one of the midwest's most beautiful cities. Interested candidates please send resume and salary history in confidence to:

William K. Marshall
THE TRANE COMPANY
3600 Pammel Creek Road
La Crosse, WI 54601

TRANE
AIR CONDITIONING

An Equal Opportunity
Affirmative Action
Employer M/F/H

Looking for a go-ahead career? Start where GROWTH OFFERS OPPORTUNITY.

General Dynamics is the nation's largest defense contractor. The Pomona Division is the Free World's leading producer and developer of tactical missiles and advanced weapons systems including Standard Missile-1, Standard Missile-2, Stinger, DIVAD, RAM, Viper, Sparrow AIM 7-F, Phalanx, Assault Breaker and more. These programs provide a continuing challenge for creative engineers in a growing company that is meeting America's defense needs for tactical systems.

At Pomona, advancing and applying state-of-the-art in engineering is a way of life.

The Pomona location offers a wide variety of lifestyles where every conceivable form of recreation is readily available year-round, with major entertainment offerings in nearby Los Angeles. General Dynamics offers you a chance to move to a company where growth does indeed mean career opportunities.

Professional openings range from entry level for recent college graduates to highly experienced employees in a wide spectrum of engineering disciplines:

Digital & Analog
Circuit Design
Guidance & Control
Systems Engineering
EMI/EMC
Test Equipment Design
Electro-Optical
Telemetry Systems
Microwave/Antenna
Fire Control Design
Microelectronics
Microprocessor Design
Engineering Writers
Hydraulic Design
Reliability
Power Supply
Electronic Packaging
Test Systems
Radar Systems
Signal Processing
Components
Stress Analysis
Electro-Mechanical Design
Auto Pilot Design
Servo Design
Logistics
ATE Design
Propulsion
Manufacturing Engineering
Industrial Engineering

Send your letter or resume for prompt technical review. You'll hear from us soon.

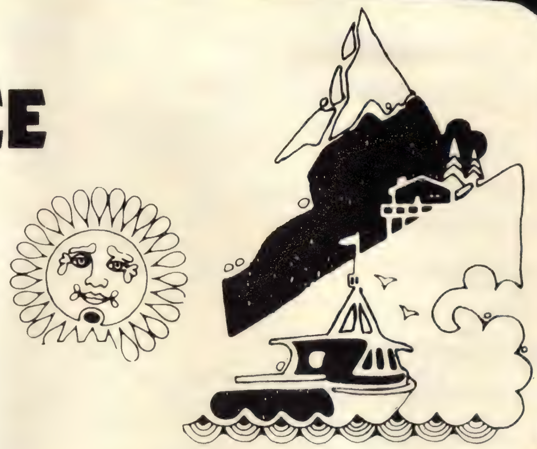
R.M. Kemp
Vice President,
Research & Engineering
GENERAL DYNAMICS
Pomona Division, Dept. 425
P.O. Box 3011, Pomona, CA 91766

An Equal Opportunity Employer M/F/H
U.S. Citizenship Required

GENERAL DYNAMICS
Pomona Division

ENGINEERS & COMPUTER SCIENCE PROFESSIONALS

You'll Like Working at Lockheed in Sunnyvale on the San Francisco Peninsula



Lockheed Missiles & Space Company is a name worth remembering. Our career opportunities have never been better for professionals eager for a challenging, responsible, meaningful environment. Your talents will expand with the diversification of programs we have to offer, and your lifestyle will be pushed to its limit with nearby beaches, ocean fishing, boating, wine country, fine schools, theatres, sporting events, and our year 'round sunny, fresh air atmosphere.

ELECTRONICS

SYSTEMS ENGINEERING

Development and analysis of advanced communication command and control systems in support of satellite missions and tactical and strategic operations. Will include application of advanced ECM/ECCM techniques.

COMMUNICATIONS

Wideband/Secure Communications systems. We need engineers to design systems involving spread spectrum, frequency hopping, and error correcting coding.

RADAR SYSTEMS

Positions available in systems and signal processor design involving SAR and other sophisticated concepts.

MICROELECTRONICS

Develop wafer fabrication processes for fabrication of GaAs, SOS, TTL, and MOS integrated circuits.

COMPUTER SCIENCE

ADMINISTRATIVE PROGRAMMERS

Experienced Administrative Programmers to work on large scale applications. Requires a Degree and two years experience in Administrative Applications.

SYSTEMS PROGRAMMERS

Requires experience at assembly language level with knowledge in any one of the following systems software areas: Operating Systems; Communications; Teleprocessing; Interactive Systems, and Associated Languages.

DATA BASE SYSTEMS

Design and development of an integrated corporate data base for Financial, Manufacturing, Engineering, Procurement, and Logistics Systems.

Most of these positions require an appropriate degree and U.S. citizenship. Several positions offer opportunities at all levels. Interested?

For immediate consideration, please forward your resume to Professional Employment, Dept. ED-580, P.O. Box 504, Sunnyvale, CA 94086. We are an equal opportunity affirmative action employer.

LOCKHEED
MISSILES & SPACE COMPANY

Engineering Opportunities

With Digital in Marlboro, MA

Everything comes together for your hardware of software engineering career at Digital in Marlboro, MA—just 45 minutes west of Boston. There's Digital itself: vast corporate resouces, state-of-the-art challenges, the stability of a world leader. And Massacchusetts, with its extraordinary richness of lifestyle. It all means *real* choices and *real* career opportunities for qualified engineering professionals.

Large Systems Product Development Group

Positions are available for Hardware and Software Engineers to join our efforts in the engineering, planning and product management of 36 bit and mid-size to large 32-bit systems. Currently we seek: • Principal/Consultant Engineer • Principal CPU Design Engineer • Principal Mechanical Engineer • CAD Software Engineers • Diagnostic Engineers • Analog Circuit Design Engineer • Disk and Tape Engineer • Product Qualification Engineer.

Please forward your resume to Mike Boyd, Staffing and Placement, Digital Equipment Corporation, Dept. G0501 3836, 200 Forest Street, Marlboro, Massachusetts 01752.

Technical Products Group

We need experienced engineers and technicial marketing professionals to become involved in our entire product line which markets to end-users and OEMs in the Laboratory, Engineering, Educational and Medical marketplaces. Products range from small single-user interactive systems to mainframe time-sharing networks. Positions include: • Software QA Engineers • Analog Circuit Design Engineers • Graphics/Structural Engineers • Senior Technical Support Specialists • Applications Software Engineers.

Please forward your resume to Steve Anderton, Digital Equipment Corporation, Dept. N0501 3836, 200 Forest Street, Marlboro, Massachusetts 01752.

Terminals Product Group

This is Digital's high-volume marketing channel for terminal products, enhancing the basic products and marketing a broad range of terminals and peripherals from the DECwriter Keyboard Printer terminals to our intelligent Video Terminals and associated options. We need: • Senior Software Engineer • Senior Hardware Design Engineer • Principal Software Quality Assurance/Reliability Engineer • Product Assurance and Support Engineers.

Microcomputer Products Group

At Digital, we've sold more 16-bit microcomputers on a board than any other company in the business. That's because our LSI-11 family of micros is quite simply the smallest, most efficient 16-bit computers ever built—micros with the power of mid-range minis. Current opportunities include: • Principal Systems Engineer • Principal Engineer • Senior Software Engineer.

If you're interested in a career within either the Terminals of Microcomputer Groups, please forward your resume to Ken Wilson, Digital Equipment Corporation, Dept. C0501 3836, One Iron Way, Marlboro, Massachusetts 01752.

We are an equal opportunity employer m/f.

digital

NOT MANY COMPANIES WILL CHALLENGE YOU WITH THE FREEDOM TO INNOVATE THEIR TECHNOLOGY.

COULTER DOES.

Innovation. Rather than the exception, it's the rule. The rule by which our accomplishments are measured.

That's one of the reasons Coulter has attained a position of world leadership in the field of biomedical electronics.

That's one of the reasons—if you've got the experience and the drive—we won't hesitate to challenge you with the freedom to innovate our technology.

Give us your **heavy EE** hands-on experience in digital/analog circuit design in a precision instrumentation environment...with a BSEE (MSEE preferred).

We'll give you the stimulating assignments, major projects, and decision-making responsibilities to garner all the satisfaction you've ever wanted...in **Standards, Product Safety, Components,** or **Electrical Design.**

And we'll give you a competitive salary, generous benefits package, and opportunity to enjoy an all-around Florida lifestyle.

Send resume in confidence to: **Mr. Pete Chylko, Employment Manager, Dept. ED, P.O. Box 5-2794, Miami, Florida 33152.**

COULTER ELECTRONICS, INC.

INNOVATING A VITAL TECHNOLOGY.

An Equal Opportunity Employer M/F

ENGINEERS

Make Your Career Count!

Litton Systems Washington based AMECOM Division, international leaders in Electronic Warfare, RF and Telecommunications, backed by new, expanded Internal Research and Development funding, seeks innovative professionals who want to work on the leading edge of technology. Right now, AMECOM has immediate career openings at all levels for:

SOFTWARE SYSTEMS ENGINEERS

- **Real-time hardware controller subsystems**
- **Real-time systems processing**
- **Assembly, Fortran, micro-code languages**

RF ENGINEERS

- **Microwave communications and receiving systems**
- **High sensitivity DF receivers**
- **Solid state microwave component design**

TELECOMMUNICATIONS SYSTEM DESIGN ENGINEERS

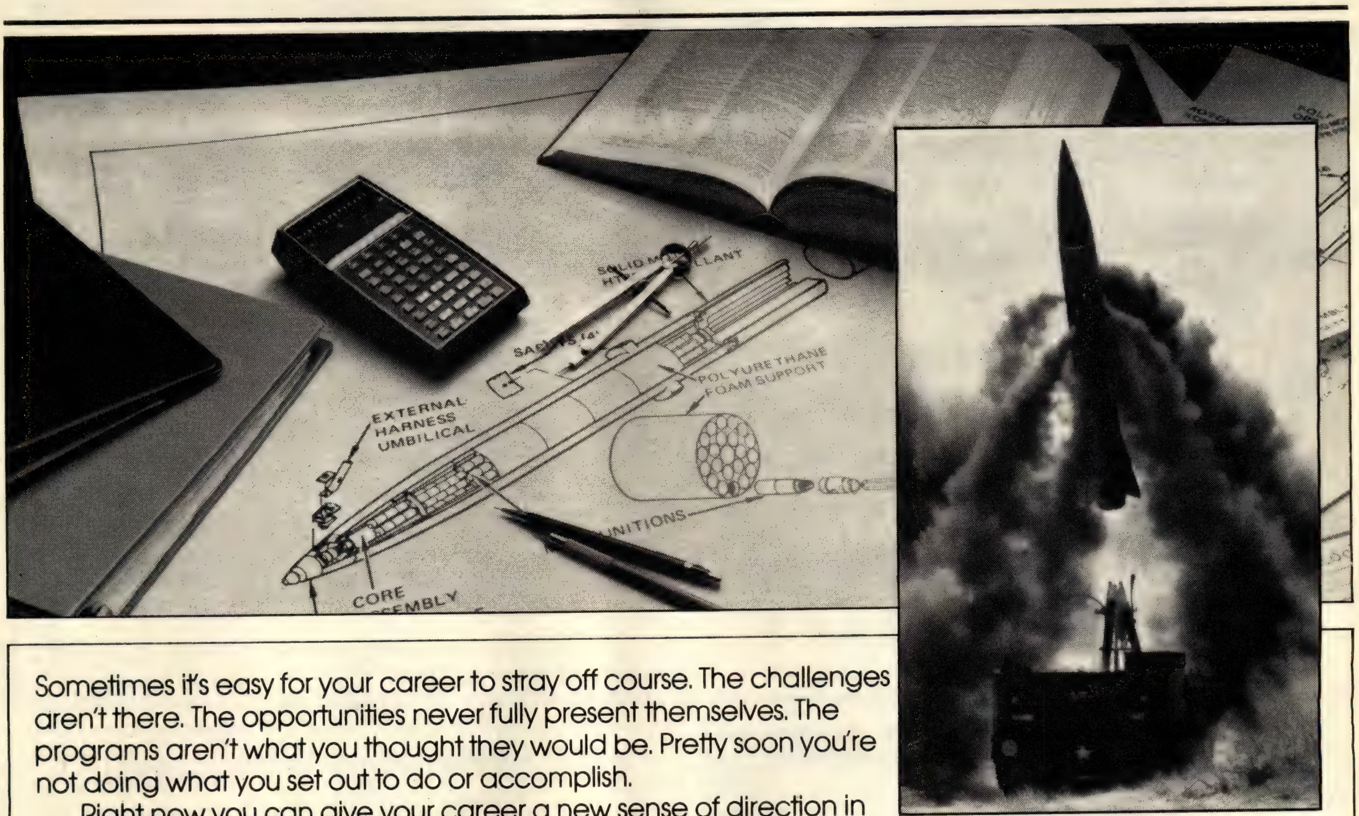
- **Advanced digital subsystems including TDM**
- **RF and analog subsystems including frequency synthesis and FDM techniques**
- **Microprocessors and related real-time operating systems software**
- **Voice switching systems**

Besides excellent compensation and benefits, we are located in a pleasant Maryland college town close to the Nation's capital with its many cultural advantages and your choice of city, suburban, country, water or mountain living. For more information, please send your resume including salary history or call TOLL FREE

DAN HUBER
(800) 638-0918

LITTON SYSTEMS, INC.
Amecom Division
5115 Calvert Rd., College Park, Md. 20740
An Equal Opportunity Employer M/F/H

GIVE YOUR CAREER A NEW SENSE OF DIRECTION AT VOUGHT.



Sometimes it's easy for your career to stray off course. The challenges aren't there. The opportunities never fully present themselves. The programs aren't what you thought they would be. Pretty soon you're not doing what you set out to do or accomplish.

Right now you can give your career a new sense of direction in missile and missile system engineering at Vought. Currently we see an emerging need for new, more sophisticated missiles and missile systems, and we are working ahead in the advanced technologies that will make them possible. We're deep into Thermochromic Electro-Optic processing. Laser Gyro Missile Guidance Integration. Hypervelocity Kinetic Energy Kill Mechanisms. And Simulation, to name a few.

For you, this spells outstanding career opportunities now — and for the years ahead. We're offering you a chance to grow, to contribute, to make your mark in the exciting world of rocket and missile system engineering. We're offering you the possibility of doing what's never been done in these fields before. That, perhaps is the biggest challenge of all. And when you succeed, the most satisfying.

Vought is located in Dallas, Texas, at the very hub of the thriving Sunbelt. It's a great place to live, work and raise your family.

If your career is losing its sense of direction, get it back on course at Vought.

We have immediate openings in the following technical areas:

Guidance and Control Systems Engineering
Digital Hardware Packaging
Digital Systems Analysis
Fracture Mechanics

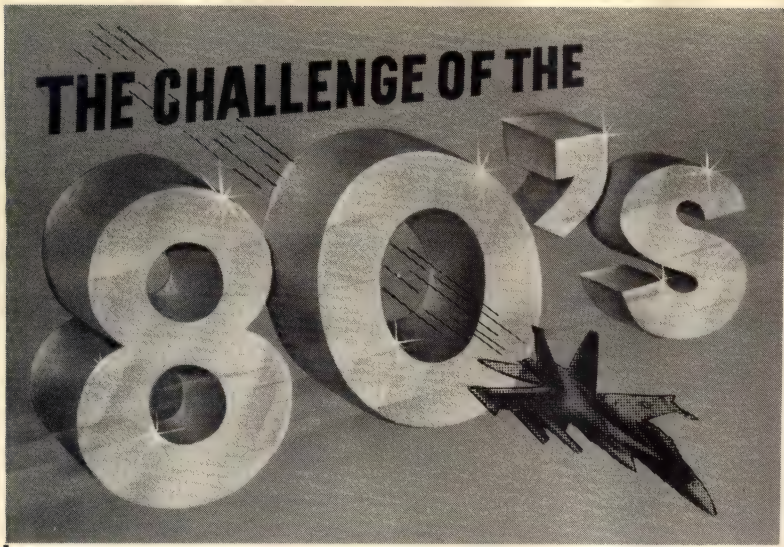
Video Electronic Design
High Speed Logic Design
Flying Spot Scanner Design
Visual Systems Design
N/C Programming
Propulsion Engineering

Computer/Software Engineering
Value Engineering
Pyrotechnic/Warhead Design
Tool Design
Technical Writing

Send your resume to:

VOUGHT an LTV company

Dept. AA-0518
P.O. Box 225907 • Dallas, Texas 75265
We Practice E.O.E. We Believe in E.O.E. ♿



...is the challenge of the future. Northrop's Defense Systems Division is committed to meet today's challenges and those to come. We need top-flight professionals with sophisticated electronics knowledge and ECM/EW experience who seek an environment which stimulates creativity, productivity and growth. Our current long-range plans and contractual commitments have created openings for the following individuals:

SYSTEMS:
- Senior Engineers
- Project Engineers
- Engineers

SOFTWARE:
- Engineers
- Analysts
- Programmers

PRODUCT DESIGN:
- Senior Engineers
- Project Engineers
- Engineers

PRODUCT ASSURANCE:
- Reliability Engineers
- Maintainability Engineers
- Quality Assurance Engineers

AUTOMATIC TEST EQUIPMENT:
SYSTEMS:
- Digital Test
- RF Microwave

SOFTWARE:
- Analog Test
- Digital Test

DESIGN:
- Mechanical
- Electrical

We provide top salaries, generous benefits and the opportunity to put your skills to work at technology's leading edge.

For consideration, forward resume to: **PROFESSIONAL EMPLOYMENT MANAGER, DEPT. ED5/10.**
(or call our 24-hour 800 number)
1-800-821-2280, EXT. 927
(Mo. Res. 1-800-892-7655, EXT. 927)

NORTHROP

NORTHROP CORPORATION
DEFENSE SYSTEMS DIVISION
600 Hicks Road • Rolling Meadows, IL 60008

as an equal opportunity employer, we encourage minorities and females to apply.

If you currently earn between $22,000 and $48,000 we've got a better job for you...NOW!

Every day you spend in the wrong job is a waste of time, money and talent...YOURS! Your talents and experience are in great demand and you can choose among many rewarding opportunities available in your field. But how?

Talk to the experts at Wallach. We've been successfully recruiting professionals like yourself for over 15 years.

Nationwide opportunities include technical/management consulting, project management, R&D, test and systems evaluation in the fields of Communications, Satellites, Weapons, Intelligence, Computer, Energy, and Aerospace systems. Specific skill areas include:

- **Minicomputers**
- **Microprocessors**
- **Software development**
- **Signal processing**
- **Digital systems**
- **Command & Control**
- **Radar Systems**
- **Communication Systems**
- **EW/SIGINT/ELINT**
- **Microwave Systems**
- **Electromagnetics**
- **Fire Control Systems**

Don't waste another day in the wrong job! Call Robert Beach collect at (301) 762-1100 or send your resume in confidence. We can find you a better job. Let us prove it to you...NOW!

WALLACH...Your career connection

Equal Opportunity Employer Agcy.

WALLACH
associates, inc.

1010 Rockville Pike
Box 6016
Rockville, Maryland 20852
(301) 762-1100

ENGINEERING OPPORTUNITIES

In order to maintain our position of leadership in the peripherals business, CPI is expanding its technical force at its Valley Forge Division. The following positions are open in the Engineering Department:

READ/WRITE CIRCUIT DESIGN ENGINEER
Requires BSEE plus experience in computer circuit analysis and analog design. Position involves circuit design, debug, and release for production.

SERVO DESIGN ENGINEER
Requires BSEE/BSME and 7 years experience in servo design involving control circuitry of AC and DC motors.

MAGNETIC RECORDING HEAD DESIGN ENGINEER
Requires BSME plus 10 years experience in the design of magnetic recording heads and evaluation and investigation of recording tape media.

HARDWARE/SOFTWARE ENGINEERS
Requires BSEE or BS Computer Science and experience in the design, development, debug and maintenance of systems software used for design verification of tape subsystems. PDP-11 or equivalent experience with assembly languages necessary. Must be capable of working in a mixed hardware/software environment and have an interest in developing a detailed knowledge of tape subsystems.

CPI offers an attractive salary, liberal benefits package and advancement opportunities in our modern suburban facility. Please send resume with salary requirements to: **F.A. LIBERI**

COMPUTER PERIPHERALS INC.
Valley Forge Corporate Center
2621 Van Buren Avenue,
Norristown, Pa. 19403 • (215) 666-5000
An Equal Opportunity Employer, M/F

COMPUTER PERIPHERALS INC.
a subsidiary of
CONTROL DATA CORPORATION

TELECOMMUNICATIONS CAREERS WITH GLOBAL IMPACT

At ITT North, we are projecting dynamic growth for the 80's. Our Cape Canaveral offices serve as a base for our expanding international projects that involve both domestic and military work. We are looking for aggressive, innovative people to sell, test, and install our central office switching equipment.

SOFTWARE ENGINEERS

BS in Computer Science or equivalent experience required. 2-5 years experience in telecommunications, with assembly language and real-time programming.

We are hiring for many projects, and are expanding the long range integrity of our operation. One immediate area of need is in advanced electronic stored-program control crossbar switching systems. Applicants should possess experience in some or all of the following areas:

- Toll Room Systems
- Number Plans and Translation
- Trunking and Alternate Routings
- Multi Processor Systems Operation
- Telephony Signaling Sciences including International R2
- Call Forwarding and Subscriber Call Forwarding including Call Waiting and Transfer
- On-Line Maintenance Programs for Tracing Telephony and Common Control Equipment
- Cross Bar Matrices and Electronics Matrices
- LAMA-CAMA Billing

Another immediate area of need is in Distributive Processing Applications for Air Weapons Communication Systems. Applicants should possess experience in some or all of the following areas:

- Call Processing
- Top Down Design
- Central Office Switching
- Message Switching
- Telephony
- Mini/Micro Computers
- Intel 8080
- On-line Maintenance/Diagnostics
- PBX

If you're the kind of electronics or electrical engineer who takes more pride in "doing it first" than in modifying other people's succes stories, join us at ITT NORTH. In addition to a great Florida location and excellent advancement potential, we also offer top starting salaries and complete benefits package. To find out more about these and other opportunities at ITT NORTH send a letter and/or resume, salary history and a copy of this ad to Employment Manager, Dept. EDM.

ITT NORTH
7321 N. Atlantic Ave.
Cape Canaveral, Florida 32920

An Equal Opportunity Employer M/F/H

ITT
ITT North Telecommunications Switching Division

ENGINEERS!

Advance your career and lifestyle on Florida's Suncoast.

SPERRY
MICROWAVE ELECTRONICS

ANTENNAS AND RF COMPONENTS

Millimeter wave guidance equipment, antennas and related RF subsystems, seeker development systems, analysis and control.

SYSTEM REQUIREMENTS DEFINITION

Software development, specification development, military ADP systems including administration, logistics, ship repair systems, C³ and weapon range systems.

SOFTWARE SYSTEMS/ENGINEERING

Real-time software, signal processing, simulator development, microprocessor development, systems analysis of ship command and control.

RADAR SYSTEMS DEVELOPMENT

Equipment engineering, design, mechanical packaging, math modeling and decision theory, fire control weapon system integration, EW systems and reliability.

TECHNICAL SUPPORT

Familiarity with government contracts and procedures which include engineering planning and financial control, components/standards engineering, design, marketing and contract administration.

Sperry Microwave Electronics is engaged in the engineering, research, development and production of sophisticated electronic systems and equipment. A dynamic force in the development of new technologies, Sperry is one of Florida's fastest growing electronics corporations. Please send your resume, including salary history, to Edward Vendley, Sperry Microwave Electronics, P.O. Box 4648, Clearwater, FL 33518.

COME GROW WITH
SPERRY
MICROWAVE ELECTRONICS

Career opportunities also exist at:

SPERRY DIVISION
Great Neck, NY 11020
ATTN: P.W. SMITH

NORTHERN VIRGINIA OPERATIONS
5400 Cherokee Ave.
Alexandria, VA 22313
ATTN: D. Gay

An equal opportunity employer M/F

ATE

OPPORTUNITY • ADVANCEMENT • CHALLENGE

If these are your objectives — that's what we're about!
MANTECH is experiencing continued, rapid growth in its ATE specialty

To support this expanding business we are seeking engineering professionals with upward motivation who are seeking challenge. We are particularly interested in professionals and technicians for:

- **Prototype hardware fabrication (Elec/Mech)**
- **ATE test techniques and applications**
- **Microprocessor software development**
- **Test program set generation**
- **Test program set validation and verification techniques and procedures.**

MANTECH is an industry leader in ATE systems and ATE software development. Opportunities are available in Northern Virginia and Long Island, NY.

Forward your resume to: B. Gaston, MANTECH INTERNATIONAL CORPORATION, 6110 Executive Blvd.,
Rockville, MD 20852.
An Equal Opportunity Employer, M/F.

management
mantech
INTERNATIONAL CORP.
technology

Grow With GCA...

GCA Corporation is a growth oriented manufacturer of instruments, equipment and systems marketed to a wide cross-section of industries and markets throughout the world.

GCA/BURLINGTON DIVISION is the leading designer and producer of photo optical equipment used in the production of advanced integrated circuits. Our equipment is used by all major IC Manufacturers worldwide.

Senior Design Engineer

To supervise and participate in opto-mechanical project design. Emphasis on mechanical instrumentation and components. BSME plus 5 years experience required.

Design Engineer

Design, debug and document various digital equipment using TTL logic and microprocessors. Emphasis on computer peripherals including interfaces. CMOS experience helpful. BSEE plus 3 years design experience.

Test Methods Engineer

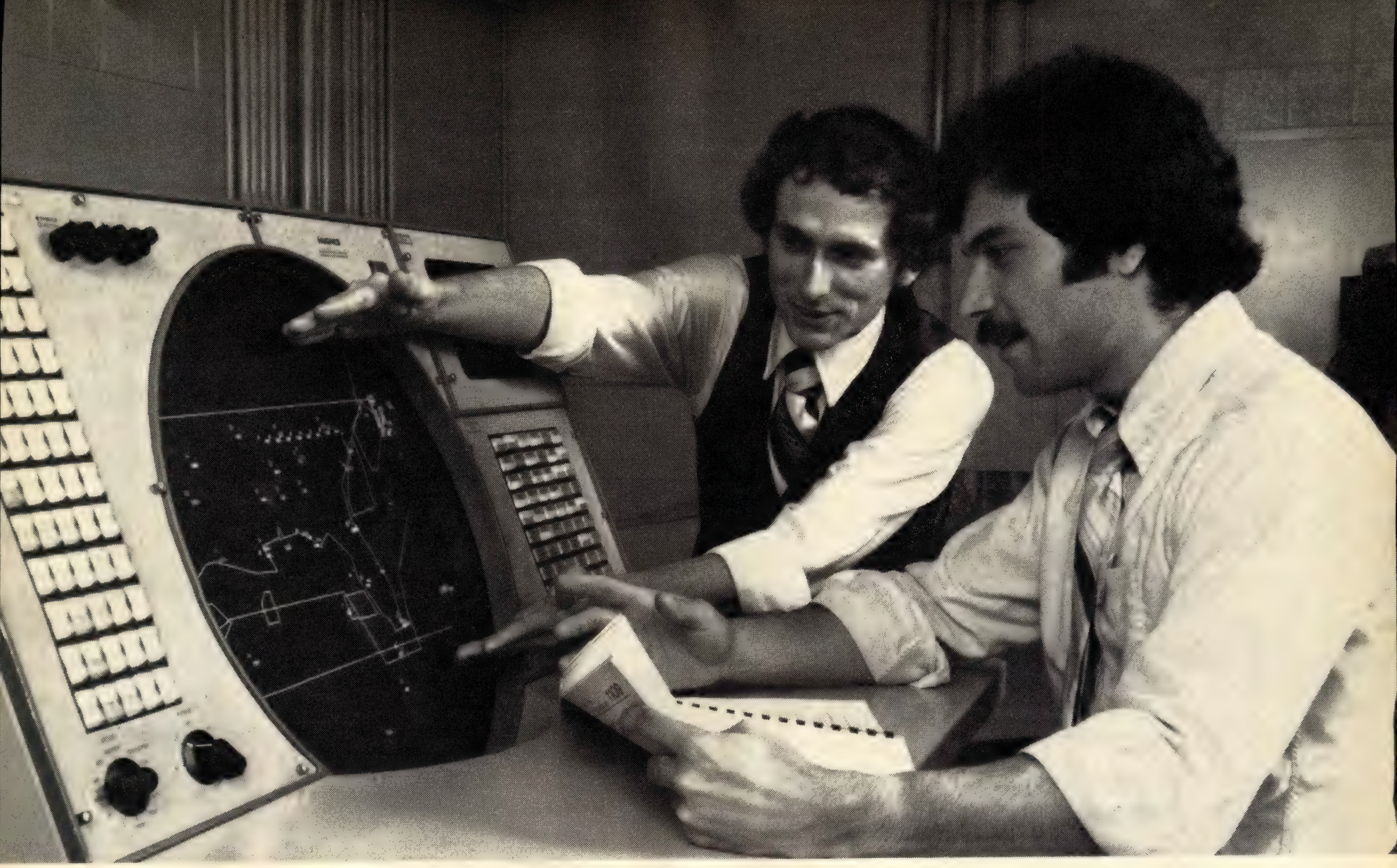
To evaluate final test and determine most efficient and economical methods of production testing. BS in engineering and 3 years experience.

Please send resume to Al Zink.

GCA
GCA CORPORATION
Burlington Division

209 Burlington Road
Bedford, Massachusetts 01730

an equal opportunity employer m/f



We'd like to work for you.

Achievements by our engineers: they are what keep us out in front, on the curl of the fast-moving wave of electronics technology.

And we never forget it.

Breakthroughs from frequency-scanning 3-D radar to computer-based technical maintenance information systems haven't been accomplished by "the company."

The credit belongs to our individual hardware, software, and firmware specialists.

Here at Hughes Ground Systems, management is always eager to work with and for members of our technical staff, to create and maintain the most productive working climate possible. We'll supply every tool you can use.

If you're an electronic engineer, computer science graduate, mechanical engineer, mathematician, or physicist —

If you want to move ahead of the industry tide in radar, special-purpose and general-purpose computers, air defense systems, EW, communications, or ASW systems —

We'll give you all kinds of support:

Support personnel — some of the most highly skilled technicians and programmers anywhere.

Computers — and access to them.

Computerized design, manufacturing, and test assistance — so advanced we had to invent much of it.

Plus a lot more. Including fellowships and other plans to make it easy to continue your education. (Competitive salary, top-of-the-industry benefits, and suburban Southern California living are extras.)

Make us a job offer.

Join us. Hughes is working on a backlog of at least 1,500 varied assignments that add up to more than \$4½ billion worth of variety, security, and future.

Tell us what you want when you send your resume to:

Hughes Aircraft Company
Ground Systems Group
Professional Employment Dept. DE-5A
1901 W. Malvern Ave.
Fullerton, CA 92634.

JOINT SURVEILLANCE SYSTEM

JSS, the new North American peacetime surveillance and control system, replaces SAGE in the U.S. and Canada.

Besides providing air sovereignty, the system will support the defense of the two nations in case of air attack through surveillance, identification, and interceptor aircraft control.

HUGHES

HUGHES AIRCRAFT COMPANY

GROUND SYSTEMS

U.S. citizenship required
Equal Opportunity M/F/HC Employer.

RCA

A Tradition On The Move!

As the New Products Advanced Development Center for the RCA Consumer Electronics Division, we are expanding our efforts to meet RCA's growing needs in the software and microcomputer systems areas. We have immediate openings that will challenge your talents and imagination in hardware, software and system design. Our location affords a rural/suburban surrounding, with exceptional cultural and recreational opportunities at a reasonable cost-of-living.

We offer a stimulating work environment for professional achievers with the following background:

Education -
A degree (preferably B.S. or M.S.) in Computer Science, Computer Engineering, Electrical Engineering, or other relevant areas.

Experience -
Openings are available for a variety of levels of experience, from recent graduates to senior engineers. Your experience/interest should qualify you to solve challenging system design problems in some of the following areas:

Digital Systems for Consumer Applications

Microprocessor Software: Systems and Applications

Software Tool Development

Signal Processing: Digital and Analog

If your background matches our needs, RCA will provide all relocation expenses, plus offer you a highly competitive compensation and benefit plan.

Send us your resume; we will reply promptly. If this communication is too slow, or you want to talk "technical", call collect - Ken Schroeder, Manager, Digital Systems Technology (317) 267-6536. All written correspondence should be directed to:

P.N. McQuade
Employment Manager
RCA Consumer Electronics
600 N. Sherman Drive
Dept. ED 0510
Indianapolis, IN 46201

Equal Opportunity Employer

Our New Products Laboratory means New Opportunities for Software and Microcomputer Systems Engineers

have a gripe?

let us know about it!

We'll help you put pressure on any company that makes promises in its ads ... then fails to deliver.

Electronic Design refuses to run advertisements deemed to be misleading or fraudulent.

ACCURACY is everybody's business. So if you have a gripe about a misstatement or inaccuracy in either editorial or advertising material in *Electronic Design* ... tell us about it. We'll do everything we can to find out what happened and see that it's corrected. Notify

Lucinda Mattera
Editor
Electronic Design
50 Essex Street
Rochelle Park, New Jersey 07662

ENGINEERS & SOFTWARE SPECIALISTS

Broad ranging opportunities to put your career on target ...at ITT Avionics, Nutley, New Jersey

You could be involved in any of these sophisticated systems:

- **Strategic/Tactical ECM Systems**
- **Electro-optical Countermeasures**
- **Tactical Navigation**
- **Computerized VORTAC System**
- **C^3 Communication-Navigation-Identification**

Projects employ advanced signal processing techniques such as:

• DTDMA • Spread Spectrum • Frequency Hopping • Multiple Access Applications • Match Filter and Correlation Techniques • FFT.

SOFTWARE ENGINEERING/ SYSTEMS DESIGN

Prefer BSEE, Physics, Computer Science, or Math and minimum 2 years real time Assembly language programming. Openings at all levels including supervisory involving:

Embedded Systems • Multi-Computer Architecture • Airborne Mini-Computers Architecture • Microprocessors • Software/Hardware Integration • Control of Advanced Receiver Sensors • Radar Warning Receivers • Threat Analysis • Radar Signal Processing • Electro Optical Scanning.

For above openings,
Call COLLECT to
H. Balbo, (201) 284-3024

DESIGN ENGINEERING

DIGITAL

BSEE required for various design assignments: State of the art high speed MSI and LSI devices, minicomputers, microprocessors, bit slicing, TTL schottky hardware/software interface.

RF Design

BSEE or Physics required for assignments in low frequencies through various microwave regions.

- **Active/passive devices implemented in stripline and microstrip at frequencies up to 3 GHz.**
- **Interface RF circuits with peripheral analog and digital controls.**
- **E/W oriented RF Design specification, integration and test from UHF to 20 GHz.**
- **Experience in solid state components and TWT's.**
- **Know SAW, frequency synthesizers.**
- **Notch filtering techniques.**
- **Solid state hi-power amps.**
- **Millimeter waveguides.**

POWER SUPPLY

BSEE or Physics required. Background in designing TWT high voltage power supplies and/or multi-output low voltage power supplies. Familiar with high-density packaging techniques, such as signal/power hybrids and/or liquid encapsulation techniques.

For Design Engineering openings,
call COLLECT to
J. Dowd (201) 284-2436.

SYSTEMS ENGINEERING

Many opportunities at all levels, if you have recent experience in any of the following disciplines:

Strategic/Tactical E/W Systems • Signal Processing-Electronic Defense Systems • Satellite Countermeasures • Embedded Microprocessor Systems • Spread Spectrum Techniques • Signal in Space Design • Selection of Power • Sensitivity • Network Protocols • Digital Filtering • Radar Warning Receivers • Threat Analysis/Emitters/ Surveillance Radar • C^3 Systems • Design of Secure Military Communications systems.

For above openings,
Call COLLECT to
S. Hojsan, (201) 284-2318

• • •

If it's inconvenient to call the individuals indicated, please send your resume to: Professional Employment, ITT Avionics Division, 390 Washington Avenue, Nutley, New Jersey 07110.

ITT AVIONICS DIVISION

An Equal Opportunity Employer, M/F

U.S. Citizenship required.

THINK SUNSHINE.

THINK INVOLVEMENT. THINK STATE-OF-THE-ART. THINK SUNSHINE. THINK VISIBILITY. THINK RECOGNITION.

THINK SUNSHINE.

If you think we're thinking a lot of sunshine, you're right. Because that's what our fantastic Fort Lauderdale location is all about. But more than that, we're thinking about all the right ingredients that add up to a growth career. We are MODCOMP. An industry leader in the design, manufacture, marketing and service of total computer systems. Where individual participation and achievement keep us at the top. And we'd like to see you achieving in positions like these:

TECHNICAL MANAGER CPU DESIGN

Minimum of 5 years' experience in computer design and/or architecture. Responsibilities include top-down system-level architecture, detailed CPU architecture, and technical design supervision for high performance minicomputer systems. BSEE required. MSEE preferred.

LOGIC DESIGN ENGINEERS

Minimum of 2 years' experience in CPU design and/or microprocessor system design. Responsibilities include CPU design architecture and detailed logic design of micro-programmed CPU products. BSEE preferred.

SR. DESIGNER PROCESS I/O DEVELOPMENT

Technically lead analog area both in data acquisition and power supplies. Experience in analog data acquisition multiplexers, A to D, D to A, S & H, low level amplifiers, etc. Experience in power supplies, both linear and switching types.

COMPONENTS ENGINEER

Minimum of 2 years' experience in component testing and evaluation, with specific familiarity with device parameters, test procedures, and specifications. Responsibilities will include evaluation and selection of IC's and discrete semiconductor devices. BSEE required.

PERIPHERAL CONTROLLER DESIGN ENGINEERS

Minimum of 2 years' experience in Peripheral Controller design. Responsibilities include Controller design architecture and detailed logic design of microprogrammed products. BSEE preferred.

ELECTRICAL PRODUCT SUPPORT ENGINEER

Minimum of 2 years' experience in design of digital to analog conversion circuits required. Responsible for follow-on support of process type I-O equipment, linear and switching regulated power supplies, and component failure evaluations. BSEE required.

MODCOMP offers excellent salaries and benefits, including dental insurance and a stock purchase plan. So when you think of your future, think MODCOMP. Send your resume in confidence to: **Mr. Richard Green, MODULAR COMPUTER SYSTEMS, INC., 1650 West McNab Road, Fort Lauderdale, Florida 33309.**

MODCOMP®

CREATING SUPERIOR TECHNOLOGY BY DESIGN.

An Equal Opportunity Employer M/F

---

career EXTRA

Electronic Design's new recruitment newspaper is reaching 130,000 engineers professionally and personally on the move

Career Extra's May issue is closing April 22 and mailing May 2.

Call Roberta Renard
at (201) 843-0550
Telecopier: (201) 843-0550
Extension 212

Big ads equal big savings

The regular or ROP rate for Electronic Design's full page black and white unit is 23% greater than the *special rate for* recruitment advertising. By using a full page, advertisers get important positioning, frequent domination of the spread — and significant cash savings. Small-space classified display ads are a bargain, too, but nothing can match *full* pages for *full* impact.

VLSI opportunities for engineers and physicists

Perhaps no other microelectronics enterprise is as growth-oriented or as strongly committed to VLSI as NCR Microelectronics in Miamisburg, Ohio.

Our success with LSI—custom CPU set, EAROM chips, non-volatile memory chips, and our very considerable MOS processing advances—has led to the rapid establishment of two other full-scale engineering and production facilities. The powerful resources of a giant computer company is solid assurance you'll be in the forefront of VLSI at NCR.

We're expanding—and staffing—for more growth. We have immediate openings in Miamisburg for EE's and Solid State Physicists who have demonstrated performance in advanced semiconductor technology. And we'll carefully consider engineers with credentials in CAD, process development, test, Q.A., or related disiciplines.

One more thing. Miamisburg, on the outskirts of Dayton, is one of the most attractive and affordable areas in the U.S. There are superior schools and fine universities providing ample opportunities for advanced studies.

If you're qualified, are a citizen or permanent resident of the U.S., arrange a prompt briefing by sending your resume in strict confidence to: Ms. Marcia Laderman, NCR Microelectronics, Dept. D74, 8181 Byers Road, Miamisburg, Ohio 45342.

NCR

Complete Computer Systems

An equal opportunity employer

E=MC²

EMERSON=MAXIMUM CAPABILITY²

From advanced electronics and armament technology to the innovative, imaginative engineers who create it, the Electronics and Space Division of Emerson means maximum capability plus. Today, as in the past, the Electronics and Space Division is actively involved in the design, development and manufacture of a broad range of electrical and electromechanical equipment. Thanks to our industry standing and long-range contractual obligations, we'll be busy for quite some time. This means we'll be looking for top-flight professionals to take on key responsibilities. Positions are available in many areas including the following:

Test Systems Applications Hardware/Software
Sr. Radar Systems Engineer
Test Systems Software
Close Combat Weapon Systems
Test Systems Design
Signal Processing Design

If you know the meaning of your own capabilities, you'll want to know more about Emerson's. We provide a progressive compensation package which includes excellent salary and complete benefits coverage. To arrange a confidential interview, contact:

Steve Subracko or Jim Lewis
314-553-4304 or 314-553-4303
Emerson Electric Co.
Electronics & Space Division
8100 W. Florissant
Station 4303, Dept. EDR
St. Louis, MO 63136
equal opportunity employer m/f

ELECTRONICS AND SPACE DIVISION
EMERSON

CHIEF ENGINEER
Power supplies, electrical subsystems, magnetic components.

ELECTRO-PACIFIC, INC.
P.O. Box 30068
Santa Barbara, Calif.
93105 (805) 964-4878

REACH THEM WHERE THEY READ

Electronics engineers and engineering managers are a special breed. They are extremely loyal to their favorite technical magazines, and *Electronic Design* is their best read favorite—by far. It's the ideal platform for your recruitment message.

Engineers . . Engineers . . Engineers . .

Gathered in one place ...

. . . not scattered about among costly and unwieldy newspaper audiences

. . . but concentrated selectively for easy reach

. . . in the proper frame of mind

To fill a big job, use a big medium
Recruiting . . . in the pages of Electronic Design, the best-read electronics publication in the world.

50 Essex Street, Rochelle Park, New Jersey 07662
Telephone: (201) 843-0550
TWX 710-990-5071

High on the list

of an engineer's required reading is Electronic Design. It is the *premier* magazine of the electronics field because it is . . .

First in market coverage — more circulation in the Electronic Original Equipment Market.

First in market penetration — more design and development engineers and managers than any other electronics magazine.

First in readership — better-read in advertiser-initiated readership studies (163 *firsts* out of 189 over the past 19 years).

First in advertiser acceptance — more pages of advertising than any other electronics publication.

50 Essex Street
Rochelle Park, N.J. 07662
Telephone: (201) 843-0550
TWX 710-990-5071

ENGINEERS

SAIL INTO A BETTER JOB AT BOEING.

If you're heading upwind and getting nowhere fast in your present job, we'd like to suggest a new tack: to Boeing.

Here you'll find plenty of opportunities to do exciting work in commercial airplanes — including the new 767 and 757 as well as our ongoing 727, 737 and 747 programs.

And whether you like to sail, ski, fish or simply look at beautiful scenery, you'll find that Seattle is a great place to do it.

To find out more about our better jobs, send your résumé to The Boeing Company, P.O. Box 3707-OSI, Seattle, WA 98124.

An equal opportunity employer.

WE NEED ENGINEERS IN THESE AREAS NOW:

▪ Avionics ▪ Engineering Operations: Change Board, Configuration, Test Integration ▪ Flight Management: E/E Flight Controls, Navigation & Guidance, Performance Management, Software-Airborne Computers ▪ Liaison Engineering ▪ Mechanical Flight Controls/Hydraulics ▪ Pressurized Door Design ▪ Propulsion ▪ Stress

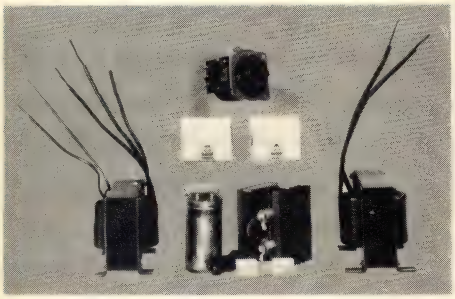
BOEING
GETTING PEOPLE TOGETHER

quick ads

New and current products
for the electronic designer
presented by their manufacturers.

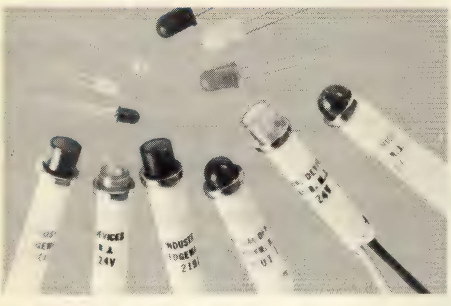
LOW-COST TEMPILABEL° TEMPERATURE MONITOR. Label's center spot turns black when surface to which it is affixed reaches specified temperature. Single- or multi-spot labels with pre-determined increment of ratings: 100°F (33°C) to 600°F (316°C). 1% accuracy guaranteed. 1 thru 8 ratings on each monitor with various increments. Self-adhesive, removable. Low as 10¢ ea. For free sample: Tempil° Div., Big Three Industries, Inc., So. Plainfield, NJ 07080. (201) 757-8300.

TEMPERATURE MONITOR **215**



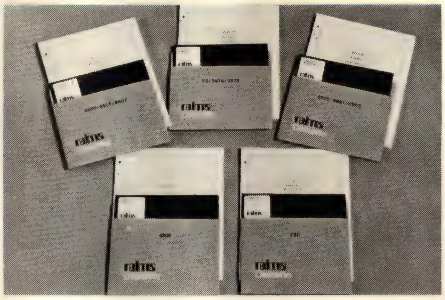
DC POWER SUPPLIES IN KIT FORM. Now available—major component groups as used in our standard production units. These can be incorporated into your consoles, plating benches an special configurations. Includes meters, silicon diodes mounted on adequate heat sinks, isolation, transformers and stepless auto transformer voltage controls in a wide variety of DC outputs. Write for complete catalog of electroplating equipment. HBS EQUIPMENT DIVISION. DEPT. 595 Supply Ave., Los Angeles, CA 90040 (213) 726-3033

DC Power Supplies **216**



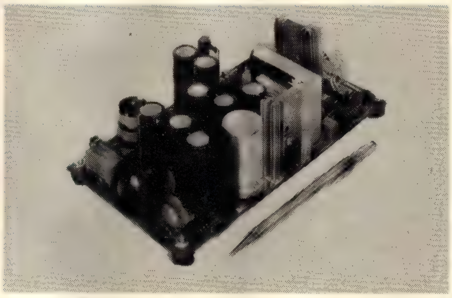
GET FREE SAMPLES of new Super-Brite LED indicator lights from Industrial Devices, Inc., Edgewater, N.J. 07020. Red, green, yellow, 100,000-hr. life. Low ac or dc power-drain, high reliability, shock-resistant. Fit 5/16″ holes. Hemispheric or flat-top. Ideal for solid-state and battery. Off-the-shelf for 6, 12, 24 volts. Call Toll Free 800-526-0488. In N.J. call 201-224-4700

SAMPLE LED LIGHTS **217**



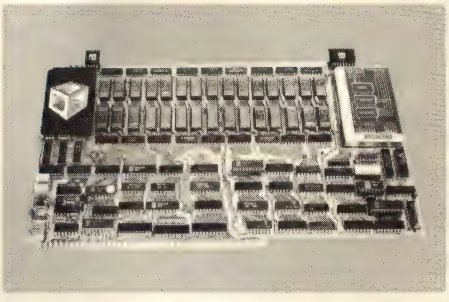
RELM's Relocatable Macro-Assemblers (RMA's) expand your Intellec® system. Completely compatible with Fairchild, Motorola, Mostek and Zilog definition features, produce ISIS II compatible output. F8/3870/3872; 6500/6501/6502; 6800/6801/6802; 6809; and Z80—each $500.00. Includes operator's manual, software license, one-year warranty and update. Order from RELMS, Relational Memory Systems, Inc. 1180 Miraloma Way, Sunnyvale, CA 94086, (408)732-5520, TWX 910 379 0014. Intellec® is a registered trademark of Intel Corporation.

RELOCATABLE MACRO-ASSEMBLERS **218**



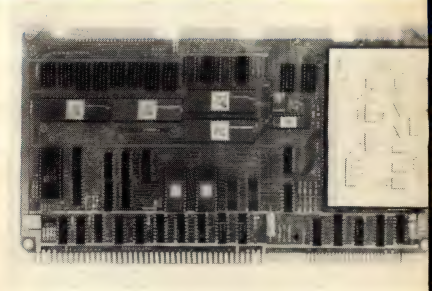
SWITCH-MODE POWER SUPPLIES 50/65 WATTS Alternate Sources to Boschert OL-50 and OL-65. Model AC-50 (50 Watts) 5V-6A, +12V-2.5A, −12V-1.0A, −5V-1A Model AC-65 (65 Watts) 5V-6A, −12V-2.5A, −12V-1.5A, +24V-1.2A, −5V-0.5A All output short-circuit protected. Designed to meet UL, CSA, BSI, Sev and VDE. Changeable; 80-140 VAC to 160-264 VAC. Conver Corp., 10631 Bandley Drive, Cupertino, Ca. 95014 (408) 255-0151

POWER SUPPLIES **219**



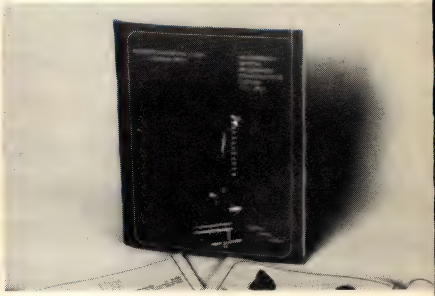
VIDEO DIGITIZER/GRAPHICS BOARD: The Multibus compatible VG-120 Graphics Board digitizes and stores real time data from a TV camera or other source, enters it into an on-board 320×240×6 bit memory, and displays it on a TV monitor as a 6 bit gray scale, or as a 64 color pseudo-color display. Indirect addressing with an auto-increment mode allows up to a 1.2 megabyte/second data transfer rate. The VG-120 allows the computer to perform graphic generation, image processing. **DATACUBE INC.,** 670 Main Street, Box 405, Reading, MA 01867. **617-944-4600**

GRAPHIC BOARD **220**



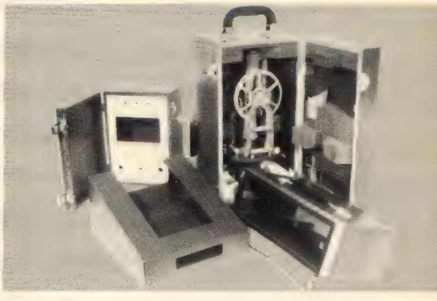
HEURIKON MLZ-DAQ MICROCOMPUTE sports ADAC ADAM-12 A/D module providi 12 bit res. 16/32 Ch. analog input. Progran mable gain optional. Other features incluc Zilog Z-80 CPU, 2 RS232C ports, dual bau rate generator, 4 8bit ports, 4 counter/timer 1K RAM, and 4/8K EPROM. Designed for Int MULTIBUS users, cards and systems are ava able. HEURIKON CORPORATION, 700 V Badger Rd., Madison, WI 5371 608-255-9075.

MICROCOMPUTER WITH ANALOG **22**



ELECTRO-OPTICAL-MECHANICAL CATALO What every Design Engineer should ow ...FREE! This new Catalog features page upo page of specifications and data for more tha 400 modular components...exceptionally use ful in Design...Development...Testing...Proto typing...Education. It's a valuable Electro Optical-Mechanical reference and sourc catalog. Send for Catalog 06/07. Klinger Sci entific Corp., 110-20 Jamaica Ave., Richmon Hill, N.Y. 11418.

ELECTRO-OPTICAL CATALOG **22**



FINE CASES AND ENCLOSURES IN STOC AND CUSTOM-BUILT Formica® laminate construction for strength and durability.

Stock line comprises more than 800 SIZE ranging up to 12¼″ × 19″ × 16″.

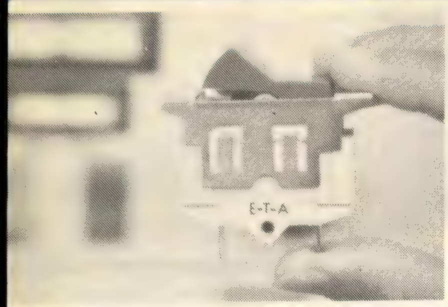
We custom-build, in any quantity, to mee exact requirements.

W. A. Miller Co., Inc., 307 Mingo Loop Oquossoc, Maine 04964. (207) 864-3344

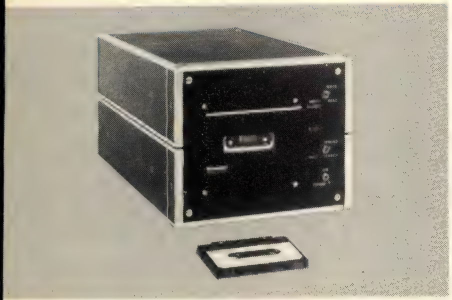
CASES AND ENCLOSURES **22**

quick ads

New and current products
for the electronic designer
presented by their manufacturers.



E-T-A COMBINATION SWITCH/CIRCUIT BREAKERS Combination saves you money because it eliminates using individual switch, circuit breaker or fuse and light. You buy, stock, mount and wire only one component. Very high reliability with 50,000 cycles mechanical and 25,000 cycles at rated load. Six handle colors. Lighted version available. Current ratings from 3 amp thru 16 amp at 250 Vac (125 Vac). UL 1077 and other world-wide approvals. Single pole about $2.50 in production quantities. E-T-A Circuit Breakers, 7400 N. Croname Rd., Chicago, IL 60648 Tel. (312) 647-8303. **224**

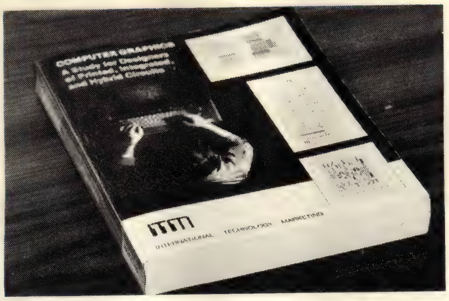


PUNCH PAPER TAPE REPLACEMENT SYSTEM MODEL 5773 CASSETTE RECORDER. Designed to directly replace punch paper tape systems the 5773 uses the more convenient and higher performance Philips cassette. Records and playsback parallel inputs up to 1,000 bytes per second. Has capacity of over 200,000 bytes per cassette. 8 control routines may be operated by front panel switches, TTL Logic or ASCII commands. Data General Model 4007/4011/4012 compatible; other computers optional. Memodyne Corp., 220 Reservoir St., Needham, MA 02194, 617-444-7000.

CASSETTE RECORDER **225**

FREE DESIGNER'S GUIDE AND MUSHIELD CATALOG presents standard and custom magnetic shields for storage, photomultiplier, and cathode ray tubes, ESCA, auger spectrometers, and special applications. Magnetic shielding materials available in sheets and coils, and preserver cases for magnetic tape, are listed. A "must have" reference for the design engineer. MuShield Corp., 151 Madison St., Malden, MA 02148. (617) 321-4410.

MAGNETIC SHIELDS **226**


COMPUTER GRAPHICS
A Study for Designers of Printed, Integrated, and Hybrid Circuits
ITM
INTERNATIONAL TECHNOLOGY MARKETING

COMPUTER GRAPHICS: A Study for Designers of Printed, Integrated and Hybrid Circuits. • Comprehensive 450-page report. • Surveys and evaluations of interactive systems, hardware, software, services. • Trends: automated placement and routing of PCBs, hybrid circuits, IC design systems. • Design requirements, cost effectiveness, system selection. INTERNATIONAL TECHNOLOGY MARKETING, 120 Cedar St., Wellesley Hills, MA 02181. Tel: (617) 237-2089

COMPUTER GRAPHICS **227**

MODEL 280 VIDEO TRANSCEIVER. Model 280 Transceiver allows video teleconferencing over normal, dial-up telephone lines, and combines three functions: freezes a single frame of video; converts the picture for transmission over audio channels; receives and reconverts these signals to conventional TV standards. Sends 256 × 256 picture elements in 35 seconds; 256 × 512 in 74 seconds. Full specifications on request. Colorado Video, Box 928, Boulder CO 80306 USA; phone 303/444-3972.

VIDEO TRANSCEIVER **228**

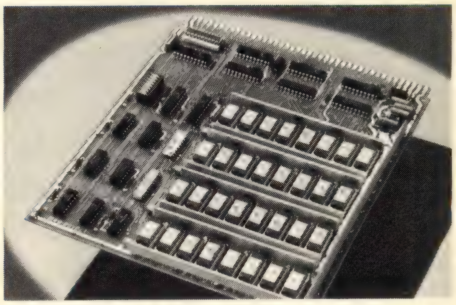
Precise 1/10 decade frequency selection. Every time. With Ithaco 24dB/Octave Dual Filter. For general lab use, acoustic studies, multichannel data acquisition, wherever precision and repeatability are critical. Frequency 10 to 1MHz, low and high pass operation, Butterworth and Bessel modes. AC/DC input coupling, selectable X1 and X10 gain, under 25 microvolts noise. Less than 0.005% distortion, over 100DB attenuation. ITHACO, Inc., 735 W. Clinton Street, Ithaca, NY 14850. Call (607) 272-7640.

DUAL FILTER (409G) **229**

POWER/MATE MAKES SWITCHER HISTORY.
5 Volts 10 Amps
$89.
THE SWITCHER COST BREAKTHROUGH YOU'VE BEEN WAITING FOR!
POWER/MATE CORP
POWER/MATE MAKES MULTIPLE OUTPUT SWITCHER HISTORY.
Five Regulated Outputs 100 Watts
$199.
THE SWITCHER COST BREAKTHROUGH YOU'VE BEEN WAITING FOR!
POWER/MATE CORP

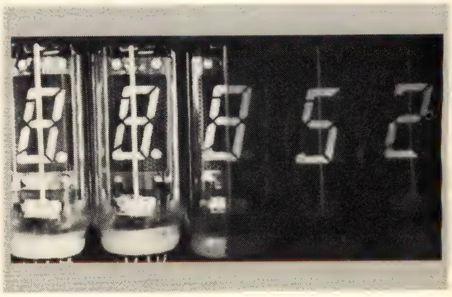
NEW SWITCHING POWER SUPPLY CATALOGS introduce the single and multiple output switching power supplies that break the switcher price barrier wide open! Top quality open-frame switching supplies with exceptional efficiency and compactness ...yet they are competitive in price with many open frame linear supplies. MTBF well over 50,000 hrs. Two-year Warranty. Meet UL and CSA standards. Power/Mate Corp., 514 South River St., Hackensack, NJ 07601 (201) 440-3100.

POWER SUPPLY CATALOGS **241**



Mini/Bus® PC bus bars—When you want to take power and ground traces off the board to have more board area for signal interconnections, have higher density packaging, avoid multilayer boards, and reduce number of decoupling capacitors, use MINI/BUS® PC board bus bars. Rogers Corporation, Chandler, AZ. 85224. Phone: (602) 963-4584. EUROPE: Mektron N.V., Gent, Belgium JAPAN: Nippon Mektron, Tokyo.

PC POWER DISTRIBUTION **242**

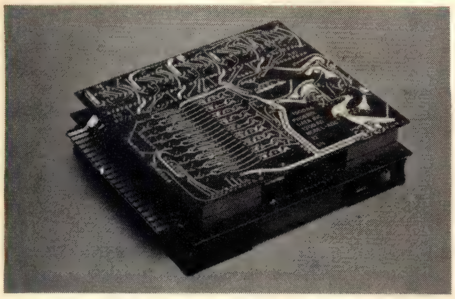


HOMALITE DISPLAY FILTERS - SHARPER CONTRAST - LOW GLARE • Color match any peak or dominant wave length • Low glare surface cast into filter. Not a lamination or coating • Excellent resistance to abrasion, common cleaning agents, chemicals and oil • Can be silkscreened for "dead-front" appearance • UL 94 flammability listing (E53966) • Plastic sheets fabricated in house, by local fabricator, by us • For "How to Design Readable Displays" + sample write. SGL HOMALITE, 11 Brookside Dr. Wilmington, 19804 (302) 652-3686

Display Filters **243**

quick ads

New and current products
for the electronic designer
presented by their manufacturers.



NEW 1216 A/D CONVERTER. . .A HIGH PERFORMANCE UNIT for digitizing high-speed, broad-band analog input signals. Resolution: 1 part in 65,535; accuracy to ±0.003%; conversion time: 14 μsec; output codes: 2's complement or offset binary. ADC 1216 utilizes a single fold-back technique in conjunction with successive approximation conversions to achieve an equivalent conversion rate of 875 nanoseconds per bit. PHOENIX DATA, INC., 3384 W. Osborn, Phoenix, AZ 85017. (602) 278-8528.

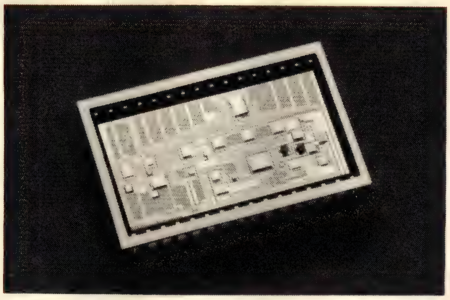
A/D CONVERTER **244**

TEMPERATURE CLOCK INDICATORS to easily monitor temperatures of electronic equipment and components. They are self adhesive and change from silver-gray to black in clock rotation upon exposure to specified temperature. Eight ranges of clocks are available between 40°C and 260°C. Each clock contains 5 temperatures. Accuracy is 1%. Size is only 0.56 in. dia. Supplied in packs of ten at 95¢ per clock by the B H Frank Co., 3733 W. 139th St., Hawthorne, CA 90250. (213) 675-6582 or 675-9182. Call or write for free sample.

TEMPERATURE INDICATORS **245**

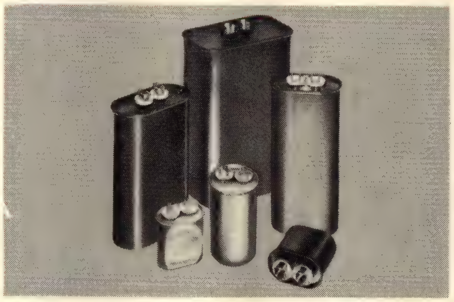
400HZ OUTPUT SCOTT T—Sine & Cosine input to Synchro output. Part #10086 is 6v to 11.8, 150 ohm load, 1 × 2 × .65; #10090 is 9v to 90, 2500 ohm load, 1-3/8 × 2-3/4 × 7/8; #13570 is 6 v to 90, 2500 ohm load, 1-3/8 × 2-3/4 × 7/8; #12945 is 6v to 11.8, 300 ohm load, 3/4 × 1-1/2 × 7/16—Magnetico, Inc., 182 Morris Ave., Holtsville, N.Y. 11742—516-654-1166. Call us for our complete line of Scott T's

400HZ OUTPUT SCOTT T **246**



5 μSec 12 Bit A/D Converter 5 μSec MN5240, pin compatible with ADC84/ADC85 converters, will double thruput in existing designs. Guaranteed no missing codes over temperature. 5 user-selectable input ranges, with optional input buffer, in a 32 pin DIP. Available in both 10 and 12 Bit linearities for both 0 to +70°C and −25 to +85°C operation. Optional screening to MIL-STD-883, Method 5008, available. $151. 1100's (0 to +70°C). Micro Networks Company, 324 Clark St., Worcester, MA 01606. Tel: (617) 852-5400.

A/D CONVERTER **247**

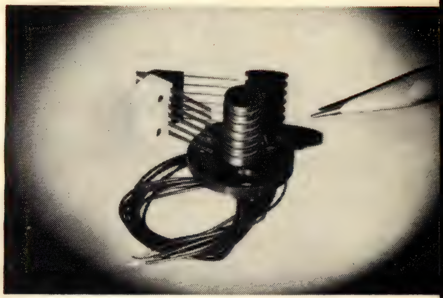


Designed specifically for Ferro Resonant Transformer and UPS applications utilizing a paper/film dielectric system to achieve smaller sizes than previous all paper designs. These designs offer improved capabilities for the higher stresses and case temperatures caused by harmonics usually associated with square wave circuiting found in these applications. Designs are available for both 70°C and 90°C temperature ratings. For information and catalog, write Aerovox Incorporated, 740 Belleville Avenue, New Bedford, Massachusetts 02741, (617) 994-9661.

POWER SUPPLY CAPACITORS **248**

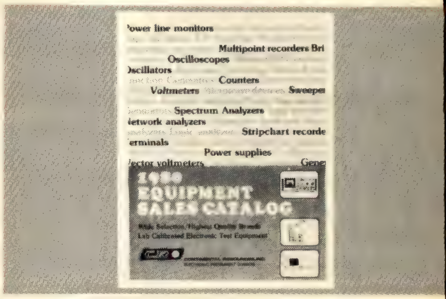
SUPER-MICRO-------10 TIMES FASTER!!! Ultra-fast 16-bit 1Mb system, only....$4995. Runs UCSD Pascal 10x faster than any micro. CPU has 64K bytes RAM, full DMA, utilities, disk controller, text editor, IEEE standard floating point hardware, RS232 I/O—50 to 19200 baud, full system software. Includes full-feature, microprocessor controlled, display/edit CRT, two dbl-density disk drives. COMPUTEX, Inc., 5710 Drexel Ave., Chicago, IL 60637, (312) 684-3183.

MICROCOMPUTER SYSTEMS **249**



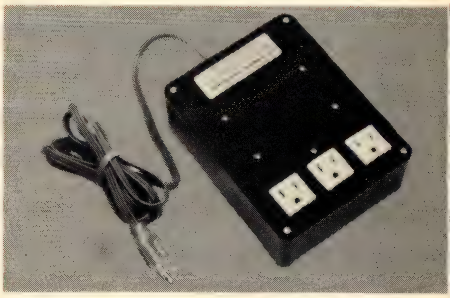
NEY STANDARD SLIP RING ASSEMBLY use in pick-off heads for instant video replay o 1980 Winter Olympics from Lake Placid. Th Ney designed, plastic molded assembly utilizes a Neyoro G gold alloy slip ring and Paliney 7 gold alloy brush blocks. Benefits are lo noise, high reliability and long life. For information write: The J.M. Ney Company Bloomfield, CT 06002.

RING ASSEMBLY **25**



SAVE 50% on like-new, lab-calibrated Electronic Test equipment. This FREE 198 catalog features equipment from leadin manufacturers, on sale. Oscilloscopes, spectrum analyzers, function generators, recorders, voltmeters, line monitors, counters, printers and more. You can write your own deal. Send to Continental Resources, Inc. 175 Middlesex Trunpike, Bedford, MA. 0173 617-275-0850

SAVE $$ ON INSTRUMENTS **251**

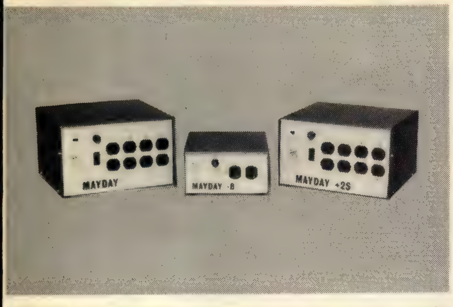


MICROPROCESSOR ISOLATORS. 3 filtered 3-prong AC sockets & integral Spike Suppression. Socket isolation eliminates equipment interaction for error-free/glitch-free operation. Also isolates from disruptive and damaging AC Power Line Spikes & Hash 125 VAC 15 A, 1875 W Total-1KW/socket 1000 Amp, 8/20 Usec Spike Suppressors
ISO-1, filter each socket........... $56.95
ISO-3, dual filter each socket....... 85.95
Electronic Specialists, Inc Dept ED 171 So. Main St., Natick, Mass 01760

ISOLATORS **252**

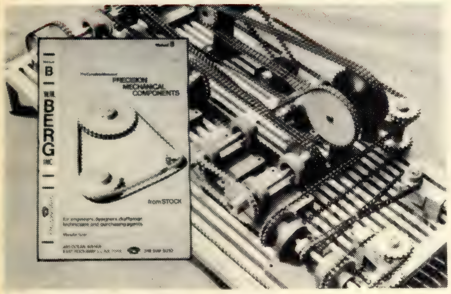
quick ads

New and current products for the electronic designer presented by their manufacturers.



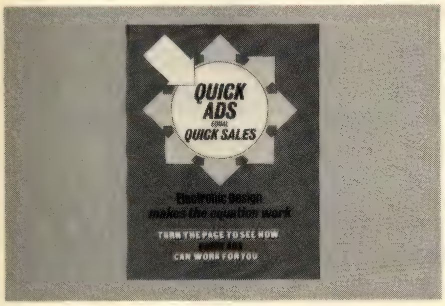
MAYDAY is an uninterruptible power supply that keeps your computer on when power fails. When interruptions occur, switch over is less than 10ms. Especially designed for mini/microcomputers. Can handle the complete business system of video, expansion interface, CPU and four disk drives. Sun-Research, Inc., Box 210, New Durham, N.H. 03855 (603) 859-7110

POWER SUPPLY 253



ELECTRO-MECHANICAL COMPONENTS-Free manual B, new for 1980 lists over 48,500 stock products including: gears, bearings, linear drive systems, hardware, breadboard kits and a unique line of engineered plastic drive belts, chain and sprockets. The manual serves as a design guide with complete reference tables and technical data. Winfred M. Berg Inc., 499 Ocean Ave., East Rockaway, N.Y. 11518. 516-599-5010.

FREE TECHNICAL MANUAL 254


QUICK ADS EQUAL QUICK SALES
Electronic Design makes the equation work
TURN THE PAGE TO SEE HOW QUICK ADS CAN WORK FOR YOU

NEW CATALOG?

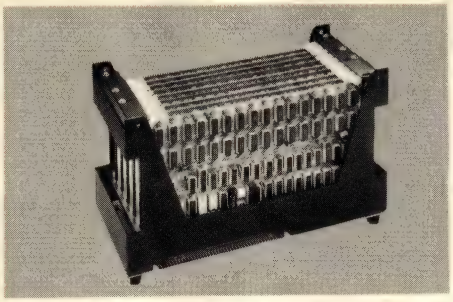
Tell us about it in

QUICK ADS

for quick response from your target audience.

Phone (201) 843-0550

255

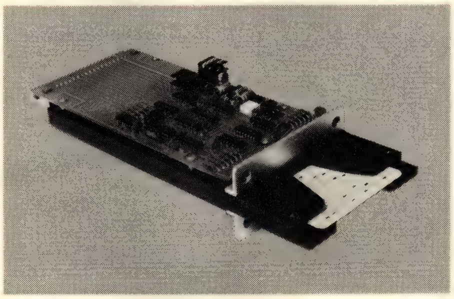


SBC 80 CARD CAGE HAS 9 SLOTS The SBC 609 card cage replaces two Intel card cages, the 604 and 614. Plus, you get a bonus 9th slot and room for a 2 level W-W card. PRICE: (1-4) $445, stock to 4 weeks. Electronic Solutions Inc., 5780 Chesapeake Ct., San Diego, CA 92123. Phone: (714) 292-0242

9 SLOT CARD CAGE 256

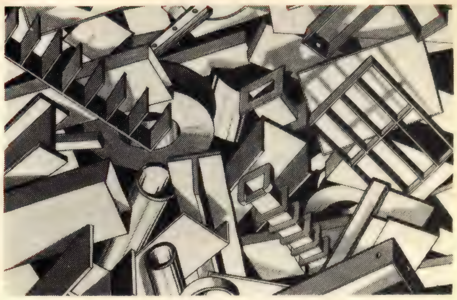
Wall Power Supply catalog charts output currents and voltages of single, dual, and triple output power supplies. AC to DC and DC to DC regulated and non-regulated. This FREE 1980 catalog features new Q series; low output ripple, excellent line and load regulation, short circuit current limiting, and a 3-watt package. Wall Industries, 2 Franklin St. Lawrence, MA 01840 (617) 688-1287

DIVERSIFIED POWER SUPPLIES 257



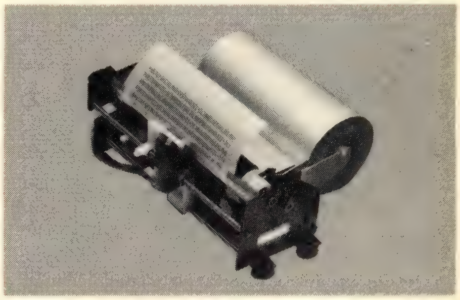
LOW COST CARD READER Reads up to 68 columns of an IBM card. No moving parts, high reliability, low maintenance, error free readout. Optically read: character/column serial; row/bit parallel. Designed for OEM and systems applications. Catalog and Application & Engineering Notes available. Taurus Corp., P.O. Box 278, Lambertville, NJ 08530 (609) 397-2390.

CARD READER 258



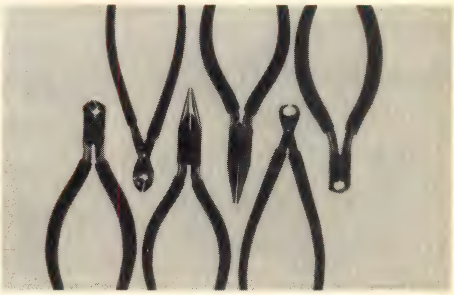
GLASS EPOXY—READY TO USE SHAPES! Thousand of sizes of glass laminated epoxy 155°C...1. Coil Bobbins & Tubing. 2. Potting Forms. 3. Structural Rods & Angles. 4. PCB Stiffeners. 5. Copper Lined Shields. . .are available from open stock tooling. Material meets MIL-C-9084, excellent mechanical and electrical values. Stevens Tubing Corp., 128 N. Park St., East Orange, N. J. 07019, 201-672-2140

INSULATORS FOR PWR. SUPPLIES 259



FAST, LOW COST, DISCHARGE PRINTER DC-4004A prints 48 columns at 144 ccps. Printing alphanumerics in 5 × 7 matrix format on 4.72″ paper, its MTBF is 144 million characters. Just 2.6″ H × 6.7″ W × 5.9″ D. It's only $127 in 100 quantity. Other printers with interface electronics available. HYCOM, 16841 Armstrong Ave. Irvine, CA 92714 (714) 557-5252.

DISCHARGE PRINTER 260

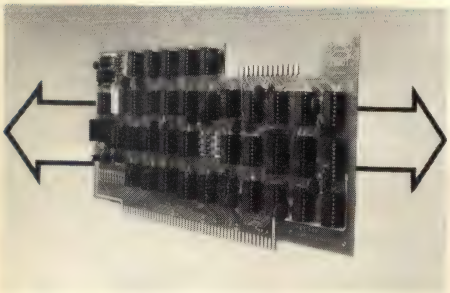


PASTORINO TOOLS, precision pliers & cutters for use in the electronics industry. These tools are finely finished *with polished heads*, or chrome plating. Many with insulated handles; serrated or smooth jaws. Send or call for free catalog: INTRADE, INC., South Street, Litchfield, CT. 06759 800-243-5252, outside CT; (567-5901 in CT, AK, HI).

PASTORINO TOOLS 261

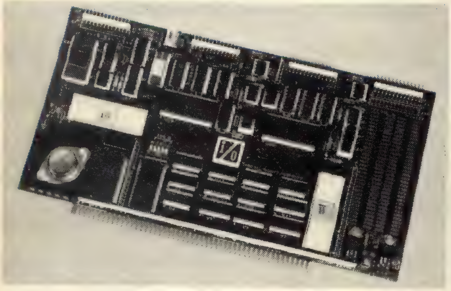
quick ads

New and current products
for the electronic designer
presented by their manufacturers.



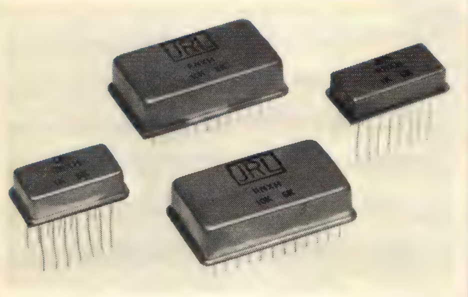
THE P&T-488 INTERFACE BOARD lets your S-100 computer to be a talker, listener, or controller on the IEEE-488 instrumentation bus. Software packages allowing high level language access to the 488 bus are available for CP/M, CDOS, North Star DOS/BASIC, as well as for direct assembly language programming. Price of the P&T-488, assembled and tested with one of the software packages, is $450. PICKLES & TROUT, PO BOX 1206 Goleta, CA 93017. (805) 967-9563

IEEE-488/S-100 INTERFACE **262**



MULTI-FUNCTION S100 I/O BOARD. New multi I/O board has two serial ports ASYNC/SYNC (RS-232, current loop or TTL) with individual baud rate generators. Four 8-bit parallel ports; one latched input port, other 3 can be programmed in combinations of input, output, or bidirectional. Regulated +5V, +12V, −12V and large proto area for user specified applications. Has 8-level programmable interrupt controller w/auto restart (8080/Z80). Assembled and tested: $375.00
29119 Flowerpark Dr., Canyon County, CA 91351 (805) 252-7666

I/O BOARD **263**

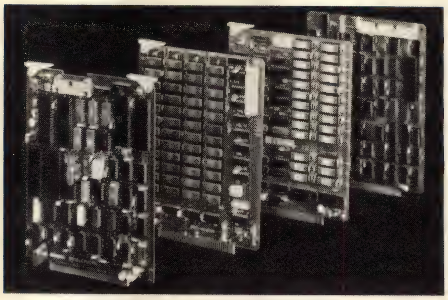


RNXH RESISTOR NETWORK has load-life ±.002%/1000 hours, which is 20 times better than the best from bulk metal film networks. Standard IC Package Configuration miniature air or oil-filled, hermetically-sealed units has resistances from below 100 ohms to 100K ohms, and resistance ratio sets from 1:1 to 10^4:1. Temperature coefficient is available from ±0.1% to ±.0025% and ±20ppm/deg. C to ±1ppm/deg. C. For fast delivery call: JULIE RESEARCH LABORATORIES, INC. 211 West 61st St., New York, N.Y. 10023, 212-245-2727.

RESISTOR NETWORK **264**

TYPICAL AD-MU CRT SHIELDS. AD-MU shields designed and fabricated to protect your CRTs from detrimental magnetic fields. As required, single or multi-layers; low, medium or high permeability alloys. Can provide structural tube support, easy access to yoke assembly, extra strength for areas subject to shock, vibration, etc. as needed. Your shielding problems end at Ad-Vance's Engineering Dept. Call us. AD-VANCE MAGNETICS, INC., 625 Monroe St., Rochester, Indiana 46975. (219) 223-3158.

MAGNETIC SHIELDING **265**



LOW COST ALTERNATIVE MICRO FOR OEM PDP-8 USERS. Getting long delivery quotes and tough prices on OEM quantities of the PDP-8 mini? Intersil's new LSI-8 microcomputer could be the answer. It comes in four modules: CPU with resident firmware monitor and dual serial I/O; 32K RAM board; 4K non-volatile CMOS RAM board and DMA floppy disk controller. Without dual floppies, systems start at $1,525. Details from:

INTERSIL, INC. 10710 N. TANTAU AVE.
CUPERTINO, CA 408-996-5325

LSI-8 MICROCOMPUTER **266**

REACOR'S NEW GOLDEN EAGLE line of power supplies has many of the features of the original line which set new standards of reliability for the industry. But the price is lower —as low as that of many ordinary power supply sources—and quicker deliveries. And when only the very best is good enough—the regular Reacor line is your obvious choice. Reacor, Inc. 831 West Miller Rd, Garland, Texas 75040. 214/271-7536

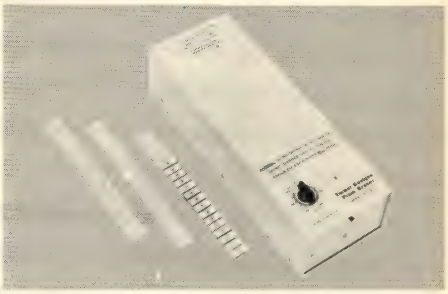
POWER SUPPLIES **267**

3MS1 *QPL Hermetic Thermostat* Single-pole, single-throw switch, activated by snap-action, bi-metal disc. Hermetically sealed with glass to metal at its terminal junction. Available to open or close on temperature rise. Qualified to meet MIL-S-24236/1. Suitable for aerospace and military applications and areas where high reliability control is required. Temperature calibrations factory pre-set. All units subjected to 100% mechanical and thermal inspection. Contact: Elmwood Sensors, Inc., 1655 Elmwood Avenue, Cranston, R.I. 02907. (401) 781-6500 TWX (710) 381-6413.

PRECISION THERMOSTAT **268**

"THE DIREKTOR," New IEEE-488 (GPIB) Instrument Controller features DIREKTOR-BASIC containing powerful commands to control devices on the GPIB. Hardware features include a full 65K bytes of RAM, dual diskettes with 250K bytes of storage, dual Z80 processors, integrated CRT/keyboard & two RS-232 ports. Uses standard CP/M operating system for flexibility. Has fantastic price/performance ratio at $3495. Qty one. HARREX CORP., PO Box 249, Kenmore, WA. 98028. (206) 823-0848

IEEE-488 CONTROLLER **269**



30-000 PROM ERASER. Angled trays eliminate "dark corner" under-erasures and insure even erasure of each EPROM. UV wavelength and intensity recommended for 2708's, 2716 and 2732. Erases 60 EPROMS simultaneously. Automatic timer. Three extra trays provided to increase throughput. Requires only minimum bench space. Contact Turner Designs, 2247 Old Middlefield Way, Mountain View, CA 94043, (415) 965-9800.

30-000 PROM ERASER **270**

quick ads

New and current products
for the electronic designer
presented by their manufacturers.

THE CLARY UPS (UNINTERRUPTIBLE POWER SYSTEM), stands between your computer system and its electrical power source. The Clary UPS protects your system during all power failures. It keeps your system going until all electrical power has been restored. The Clary UPS are available in .75 KVA through 15 KVA. CLARY CORPORATION, San Gabriel, Ca. 91776 (213) 287-6111

POWER SYSTEM **271**

Looking for a

CUSTOM LSI?

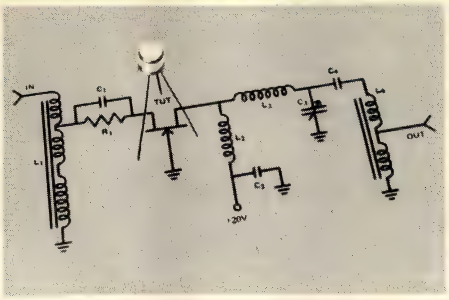
Let HOLT solve your problem.

HOLT'S CUSTOM IC DESIGN SERVICES PROVIDE • A cost effective approach to Custom LSI. • Wide design experience in analog/digital circuits and CMOS ICs. • Fast turnaround time from design to prototypes. • In-house CALMA System. • Digitizing and Plotting Service. • Computerized Design Rules Checks. We are specialists in telecommunications, timekeeping, medical, industrial, consumer and security system ICs, Contact Gary Rawlings - (714) 754-1844. Holt, Inc. 3303 D-5 Harbor Blvd., Costa Mesa, CA. 92626.

DESIGN SERVICES **272**

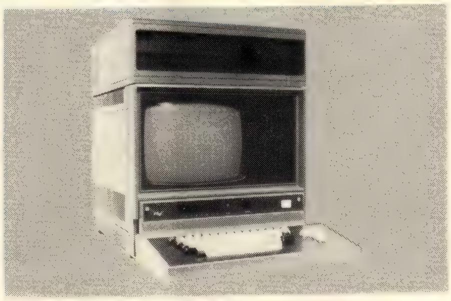
For Product Samples
For Special Offers
use
QUICK ADS
and reach your prime audience
Phone
(201) 843-0550

273



HIGH VOLTAGE BROADBAND RF FET High dynamic range RF FETs now available up to 50V BVDGO, for use with 24 & 32V supplies, and where higher drain voltage improves dynamic range. The CP664 (30V), CP665 (40V), and CP666 (50V) have third order intermodulation intercept > +40 dBm, and 50 Ohm VSWR <1.5 to 1 over 0.5 to 50 MHz range. Price in 100's: CP664 $11.39, CP665 $12.54, CP666 $13.69. Teledyne Crystalonics, 147 Sherman St., Cambridge MA 02140 (617) 491-1670.

HIGH VOLTAGE RF FET **274**



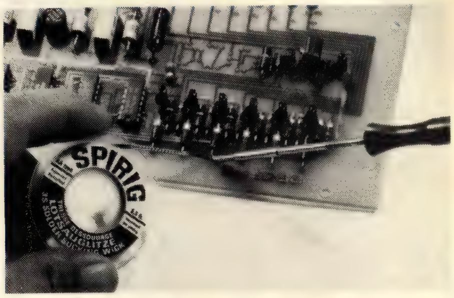
RENT INTEL

The Intel Microcomputer development system is ready for off-the-shelf rental at rates that make sense. We offer the complete range of Intel equipment including the ICE-86 plug-in emulator. Plus, other major systems such as Motorola, Millennium, Pro-Log, LSI, and Tektronix. For a free copy of our rental guide, call Microcomputer Rentals **TOLL FREE** (800 235-5955. In Ca., call collect (213) 991-1704; (415) 861-0663; or (408) 280-1839.

RENT INTEL **275**

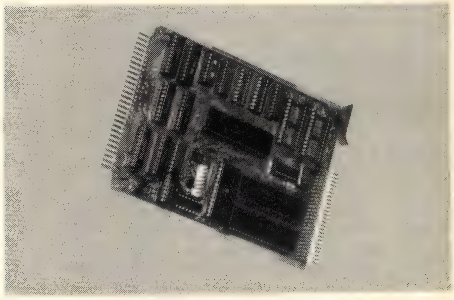
The BANKER is a dual-width interface card which allows any DEC LSI-11 to control up to 256 KB of memory using standard memory cards. Other features include: automatic bank switching for DMA and interrupts, and common ROM and RAM. Renaissance Systems, Inc. 11760-M Sorrento Valley Road, San Diego CA 92121 (714) 452-0681.

MEMORY BANK SWITCH **276**



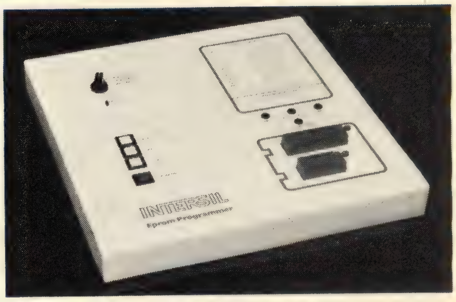
DOWN WITH DE-SOLDER COSTS 3S-WICK® available by the pounds in precut length in sealed plastic bag. Why pay for spools and bobbining? Good-bye vacuum suckers. Safe NASA wicking now for everybody at lowest cost. NASA quality public. NPC-200 (Bobbined 3S-WICK from Allied Electronics) S.A.T. Inc. 357 Cottage Street, Springfield, MA 01104 (413) 788-6191. TWX-710-350-6466 SPIRIG P.O. Box 160 Ch 8640 Rapperswil, Switzerland (055) 274403, Telex 875400

DE-SOLDER BRAID FREE SAMPLES **277**



STD BUS SINGLE CARD COMPUTER/CONTROLLER uses 6502 MPU. Provides cost effective solution for small systems. 1K RAM (sockets for 1K more), sockets for 2, 4, or 8K ROM, RS232/20 ma. serial I/O, 32 lines parallel I/O, 4 timers. Other 10000 series Microcomputer modules include 10805 6809 mpu SCC/C, 10701 Nonvolatile RAM, 10702 Nonvolatile RAM/ROM, 10301 Video Display, and 10303 202 Modem. Call today. ENTERPRISE SYSTEMS CORP., Box 643 Dover, NH 03820. Phone 603-742-7363.

CARD COMPUTER/CONTROLLER **278**



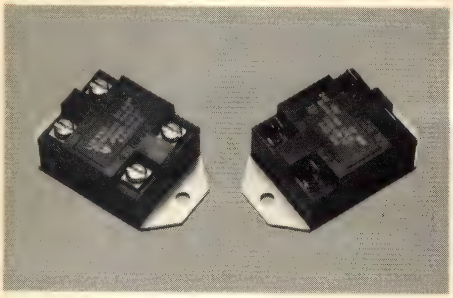
LOW COST CMOS EPROM PROGRAMMER. The 6920 is a microprocessor controlled programmer for all Intersil CMOS EPROM products. It is operable stand-alone for duplication, as a slave to a development system or a master with an ASCII terminal. Baud rates from 110 to 9600 and either RS-232C or 20mA current loop serial I/O with check sum error detection are standard. Self contained DAC controlled power supplies allow fast, convenient operation. Details from:

INTERSIL, INC. 10710 N. TANTAU AVE.
CUPERTINO, CA 95015 408-996-5325

EPROM PROGRAMMER **279**

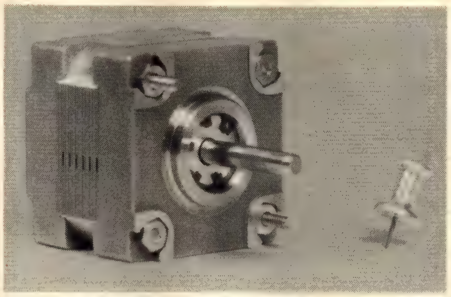
quick ads

New and current products
for the electronic designer
presented by their manufacturers.



MINI SSRs ARE 1/2 THE SIZE/WEIGHT. Providing all the high performance benefits of the "older-generation" bulky types, Guardian's MSSR/TSSR SSR Series save 50% on board "real estate" and wht. The stud-terminal MSSR comes in 5 & 10A rms, while the TSSR —with push-on terminals—is available in 2.5, 10, 20 & 30A rms. 3 DC inputs—resistive, constant current for TTL/CMOS circuits & microprocessor compatible. 20-140VAC or 40-280VAC outputs. GUARDIAN CALIFORNIA, 4030 W. Spencer St., Torrance, CA 90503. 213-542-8651.

MSSR/TSSR SERIES **280**

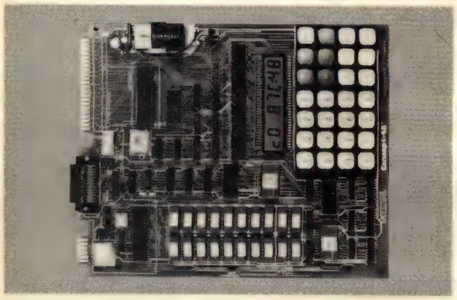


The RDM 253/25 is a 42 x 42 x 34 mm, PM, 2-Phase, 3.6° stepping motor with 17 gmcm^2 rotor inertia, assuring torques up to 7.5 Ncm, and up to 10 KHz input pulse rates. Iron end caps limit surface EMI to less than 5 Gauss. Berger-Lahr Corp., Jaffrey, NH 03452.

ROM 253/25 **283**

COTO MICRO-MINIATURE RELAYS FOR MAXIMUM PERFORMANCE COTO micro-miniature relays handle fast digital pulses without degradation of pulse edges. l/3 smaller than a DIP, they offer the same switching capabilities as miniature relays, plus high frequency handling. Available in a variety of contacts and coil resistances, they're ideal for use in ATE, digital switching matrixes, computer interfacing and more. Coto Corporation, 65 Pavilion Avenue, Providence, RI 02905. Tel: (401) 467-4777. TWX: 710-381-8016.

MINIATURE RELAYS **286**

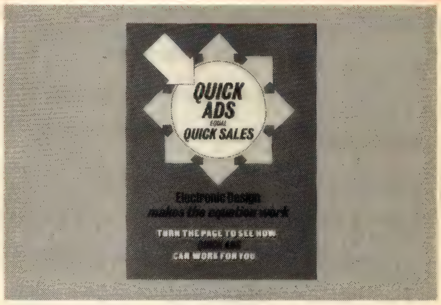


SINGLE BOARD 8048 DEVELOPMENT TOOL. CONCEPT-48, a unique development tool for 8048 family, is a compact, inexpensive, low power, single board microcomputer with keypad, LCD, 2K of writable program memory, 256 bytes of external data memory, RS-232C/20mA loop serial I/O with 12 switch selectable baud rates, 8 user selectable breakpoints, single step instruction and expansion capability. Manual and battery eliminator included. PRICE: $995. Details from:
INTERSIL, INC. 10710 N. TANTAU AVE.
CUPERTINO, CA 95014 408-996-5325

CONCEPT-48 **281**

AC MAGNETIC FIELD PROBE. Accurately measures field intensity. Sensitivity 60 mV/gauss. Axial (shown) or transverse pickup coil orientation available. Shielded banana plugs on 3/4" centers fit typical VTVM or oscilloscope. $79.50. MAGNETIC SHIELD DIVISION, PERFECTION MICA COMPANY, 740 N. Thomas Drive, Bensenville, Ill. 60106, USA. Phone: 312/766-7800

MAGNETIC FIELD PROBE **284**

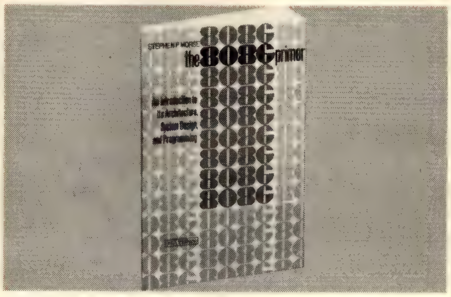


NEW CATALOG?
Tell us about it in
QUICK ADS
for quick response from
your target audience.
Phone (201) 843-0550

287

CONTROL COMPUTER/DEVELOPMENT SYSTEM—6800 MPU, serial I/O, 48K RAM, dual 8" drives, WIZRD multitasking DOS, Editor, Assembler, 12K BASIC. All for $3995. SOFTWARE OPTIONS—C compiler, PL/W compiler, PASCAL. HARDWARE OPTIONS—EROM Programmer, analog I/O, parallel I/O, 488 GPIB. WINTEK Corp., 1801 South Street, Lafayette, IN 47904; 317-742-8428.

SPRINT 68 MICROCOMPUTER **282**



THE 8086 PRIMER: An Introduction to its Architecture, System Design, and Programming, S. Morse. Written by the man responsible for the architectural definition of the 8086 processor. Describes the 8086 chip in depth, the motivation for the design of the chip, corrected procedures, and internal architecture. #5165-4, 224 pages, $8.95. **CIRCLE THE INFO RETRIEVAL NUMBER TO ORDER 15-day exam copy.** When billed, remit or return book with no obligation. Hayden Book Co., 50 Essex St., Rochelle Park, NJ 07662.

#8086 PRIMER **285**

For Product Samples
For Special Offers
use
QUICK ADS
and reach your
prime audience
Phone
(201) 843-0550

288

ElectronicDesign

ELECTRONIC DESIGN'S function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
- To give the electronic design engineer concepts and ideas that make his job easier and more productive.
- To provide a central source of timely electronics information.
- To promote communication among members of the electronics engineering community.

Want a subscription? ELECTRONIC DESIGN is circulated free of charge to those individuals in the United States and Western Europe who function in design and development engineering in companies that incorporate electronics in their end product and government or military agencies involved in electronics activities. For a free subscription, use the application form bound in the back of the magazine or write for an application form.

If you do not qualify, paid rates for a year's subscription (26 issues) are as follows: $35. U.S., Canada, Mexico, Central America. International annual subscription rates listed below include air delivery: $65. Europe; $100. Mideast, North Africa, South America, Japan; $130. Central and South Africa, New Zealand, Australia and all other Asia. Single copies (when available) may be purchased for $4. U.S., Canada, Mexico, Central America and $5. in all other countries. The GOLD BOOK (27th issue) may be purchased for $35. U.S., Canada, Mexico, and $45. all other countries.

If you change your address, send us an old mailing label and your new address; there is a card bound into the back of the magazine for this purpose. Please allow 6 to 8 weeks for address change to become effective. You must requalify in order to continue receiving ELECTRONIC DESIGN free of charge.

The accuracy policy of ELECTRONIC DESIGN is:

- To make diligent efforts to ensure the accuracy of editorial matter.
- To publish prompt corrections whenever inaccuracies are brought to our attention. Corrections appear in "Letters."
- To encourage our readers as responsible members of our business community to report to us misleading or fraudulent advertising.
- To refuse any advertisement deemed to be misleading or fraudulent.

Individual article reprints and microfilm copies of complete annual volumes are available. Reprints cost $6.00 each, prepaid ($.50 for each additional copy of the same article), no matter how long the article. Microfilmed volumes cost $23 for 1976 (Vol. 24); $30 for 1973-75 (Vols. 21-23), varied prices for 1952-72 (Vols. 1-20). Prices may change. For further details and to place orders, contact Customer Services Dept. University Microfilms, 300 N. Zeeb Rd., Ann Arbor, MI 48106. (313) 761-4700.

Want to contact us? Address your correspondence to:

Editor
ELECTRONIC DESIGN
50 Essex St.
Rochelle Park, NJ 07662

ElectronicDesign

Advertising Sales Staff

Rochelle Park, NJ 07662
Thomas P. Barth,
Eastern Regional Sales Manager
Robert W. Gascoigne, Andrew Meehan,
Constance McKinley, Becky McAdams,
Roberta Renard, Stan Tessler,
Diana Andress, Carol Helton
Sales Assistants: Deborah DiPilla,
Francine Guerra, Dale Siegel,
Betsy Tapp
50 Essex St.
(201) 843-0550
TWX: 710-990-5071
(HAYDENPUB ROPK)

Philadelphia
Thomas P. Barth (201) 843-0550

Boston
M. E. "Casey" McKibben, Jr.
113 River St.
Waltham, MA 02154
(617) 893-4441

Chicago 60611
Thomas P. Kavooras, Craig L. Pitcher
Sales Assistant: Christine Perkins
200 East Ontario
(312) 337-0588

Cleveland
Thomas P. Kavooras (312) 337-0588

Texas
Craig L. Pitcher (312) 337-0588

Los Angeles 90045
Stanley I. Ehrenclou, Burt Underwood
Sales Assistant: Betty Fargo
8939 South Sepulveda Blvd.
(213) 641-6544

San Francisco
Robert A. Lukas,
Western Regional Sales Manager
Neal Manning
Sales Assistant: Nancy Miguelgorry
1307 South Mary, Suite 212
Sunnyvale, CA 94087
(408) 736-6667

United Kingdom-Scandinavia
Constance McKinley (201) 843-0550

Germany: Annemarie McCalla
50 Essex St.
Rochelle Park, NJ 07662
(201) 843-0550

Belgium, Holland, Switzerland
W.J.M. Sanders
S.I.P.A.S.
Raadhuisstraat 24 - P.O. Box 25
1484 EN Graft-de-Ryp, Holland
Tel: 02997-1303 and 3660
Telex: 13039 SIPAS NL
Telegrams: SIPAS-Amsterdam

France: Annick Wolff
Promotion Presse Internationale
7 ter Cour des Petites Ecuries
75010 Paris, France
Telephone: 247-12-05

Italy: Robert M. Saidel
Technimedia International
Piazzale Cadorna 4
20123 Milan, Italy
Tel: 80-1646
Telex: 25897 Utidioma

Tokyo: Haruki Hirayama
EMS, Inc.
5th Floor, Lila Bldg.
4-9-8 Roppongi
Minato-ku, Tokyo, Japan
Phone: 402-4556
Cable: EMSINCPERIOD, Tokyo

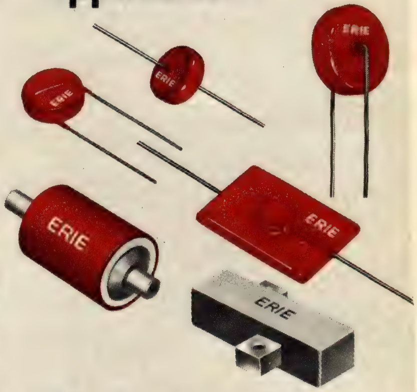
Recruitment Advertising Manager:
Roberta Renard (201) 843-0550

ABP BPA

HI-VOLTAGE CERAMIC CAPACITORS

to 30kV

in configurations to suit your application



ERIE offers a broad range of high quality components with physical styles, leads, capacitance . . . and voltages to suit your needs. These popular capacitors are widely used in electric utility transformers, power supplies, voltage multipliers for CRT displays, image intensifiers for night vision apparatus, navigation equipment and electro-optic equipment . . . literally any application involving high voltage ceramic capacitors.

Write on your company letterhead for our new catalog 3900-R1 . . . or call 814-237-1431.

ERIE

ERIE TECHNOLOGICAL PRODUCTS, INC.
State College, Pa. 16801
814-237-1431

CIRCLE NO. 289

Index Of Advertisers

AMF Electro-Components Div. ... 296
A Q Systems, Inc. ... 208
AVX, Inc. ... †55
AVX Ltd. ... *54P-Q
Abbott Transistor Laboratories, Inc. ... 16
Acheson Colloids Company, Electrical Products ... †366
Acromag, Inc. ... 195
Adaptive Science Corp. ... 286
Ad-Vance Magnetics ... 394
Advanced Circuitry ... †58
Advanced Micro Devices ... 8-9
Aerovox Industries ... 392
Agfa-Geuaert N.V. ... *54L
Airpax Electronics, Cambridge Div. ... 247
Airpax Electronics, Cheshire Div. ... 102
Ampex Corporation ... †304
Amphenol North America division Bunker Ramo Corporation ... 318, 319
Analog Devices, Inc. ... 32, 33, 43
Applied Digital Data Systems ... 266
Applied Dynamics International ... 289
Applied Microsystems ... 349
Arnold Magnetics Corp. ... 331
Aromat ... 178
Augat, Inc. ... 346-347
Avantek, Inc. ... 63
Axiom ... 183
B & K Precision ... 26
B.H. Frank ... 392
Basler Electric Co. ... 280
Beckman Instruments, Inc. ... 350
Belden Corporation ... 278
Berg, Winfred M. ... 393
Berg Electronics, Inc. ... 292-293, 295
Berger-Lahr Corp. ... 396
Boschert Associates ... 85
Bourns, Inc. ... Cover IV
Brand Rex Company ... 158-159
Burroughs Corporation ... 156-157
C. Itoh Electronics ... 273
Cambion ... 357, 359
Canon, USA ... 372
Carr, Division of TRW ... 225
Centralab Electronics ... †362, 363
Chromatics, Inc. ... 268, 269
Clary Corp. ... 395
Clifton Precision ... 351
Colorado Video ... 391
Computer Automation, Inc. ... 14
Computer Design Applications, Inc. ... 226
Computex ... 392
Continental Resources ... 392
Contraves AG ... *54T
Conver Corp. ... 390
Coto Corporation ... 396
Cromemco ... 114
Cubit ... 371
Custom Connector Corporation ... 317
Custom Electronics, Inc. ... 306
Cybernetic Micro Systems ... 272
Data Cube ... 390
Data Display Products ... 29
Data General Corporation ... 73
Data I/O Corporation ... †175-176, 177
Data Instruments Inc. ... 372
Datametrics, Inc. ... 333
Datel Intersil ... 223, 224
Deltron, Inc. ... 283
Dialight, A North American Philips Company ... 131
Dosc ... 355
EMM-SESCO ... 352
E-T-A Circuit Breakers ... 391
E-Z Hook ... 348
Eagle-Picher Industries, Inc. ... †297
Eaton Corporation, Cutler-Hammer ... 132
Elco Corporation ... 124
Electronic Design ... 209, 210, 211, 345
Electronic Measurements, Inc. ... 275
Electronic Solutions ... 393
Elgar Corporation ... 217
Elmwood Sensors, Inc. ... 394
Elpac Power Systems ... 236
Enterprise Systems ... 395
Erie Technological Products, Inc. ... 397
Erni & Co. ... †337
Facit, Inc. ... 270
Fairchild SATS Division ... 52-53
Fairchild Semicondcutor ... 196-197
Farrand Controls ... 166
First Computer Corp. ... †343
Fluke Mfg. Co., Inc., John ... 168
Forth, Inc. ... 64
GTE Microcircuits ... 87
GenRad ... †300-301
General Semiconductor Industries, Inc. ... 90
Gold Book, The ... 308, 332
Gordos Corporation ... 308, 309
Gould, Inc. ... 77, 78, 100, 334
Gould, Inc., Instruments Division ... 243, 245
Grayhill, Inc. ... 271
Greenray Industries, Inc. ... 326
Guardian California ... 396
Gulton Industries, Inc. ... 288
H.B.S. Equipment ... 390
Harrex ... 394
Harris Semiconductor, A Division of Harris Corporation ... 30-31
Heinemann Electric Company ... 348
Hellman Associates ... 218
Hewlett-Packard ... 10, 46-47, 184-185, 327, 328, 329
Heurikon ... 390
Heyman Manufacturing Company ... 332
Hitachi Electronics Co., Ltd. ... †340-341
Holt Integrated ... 395
Houston Instruments ... 291
Hybrid Systems Corporation ... 75
Hycom ... 393
ILC Data Devices, Inc. ... 98
IMC Magnetics Corporation ... 351
I/O Technology ... 394
Industrial Devices Inc. ... 390
Industrial Electronic Engineers, Inc. ... 330
Intel Corporation ... 12-13, 248-249
International Light, Inc. ... 400
International Technology Mktg. ... 391
Intersil ... †59-62, 394, 395, 396
Interdesign, Inc. ... 237
Intrade, Inc. ... 393
Ion Physics Corporation ... 326
Ithaco, Inc. ... 160, 391
Janco Corporation ... 17
Julie Research Labs ... 394
Kepco, Inc. ... 257-264, 265
Key Tronic Corp. ... 149
Kikushi International ... 322
Klaasing-Reuvers Produktie B.V. ... *54S
Klinger Scientific Corp. ... 390
Laser Diode Labs ... 324
Lewisystems ... 356
Litronix, Inc. ... †54
Magnetico, Inc. ... 392
Magnetic Shield Division, Perfection Mica Company ... 334, 396
Memodyne Corporation ... 391
Microcomputer Rental ... 395
Micro Networks Corporation ... 392
Micro Switch, A Division of Honeywell ... 151
Microsoft ... 89
Midtex,Inc. ... 18
Miller Co., Inc., W. A. ... 390
Minelco, a Talley Industries Co. ... 325
Mini-Circuits Laboratory, A Division of Scientific Components Corp. ... 6, Cover III
Monolithic Memories, Inc. ... †56-57
Monolithic Systems ... 202
Mostek Corporation ... 24-25
Motorola Inc. ... 91, 314
Motorola Semiconductor Products, Inc. ... 105-112
MuRata Corporation of America ... †364
MuShield Corp. ... 391
NEC Micro Computers, Inc. ... †302-303
National Semiconductor Corporation ... 19-22
Ney Co., J.M. ... 392
Nichicon America Corporation ... †344
North Atlantic Industries, Inc. ... 287
North East Expositions ... 256
Nuvec Laboratories,Inc. ... 372
OPTO 22 ... 123
OK Machine & Tool Corporation ... 186
Oshino Electric Lamp Works, Ltd. ... 372
PTK Corporation ... 348
Panasonic Electronic Components ... Cover II, †336, 336A-D
Panelgraphic Corp. ... 400
Philips CD/Elcoma ... *54B-C, *54 J-K
Philips Test & Measuring Instruments, Inc. ... *54F-G, †298-299
Phoenix Data, Inc. ... 392
Pickles + Trout ... 394
Plessey Microsystems ... *54
Power Dynamics, Inc. ... 290
Power/Mate Corp. ... 41, 391
Power One, Inc. ... 285, 354
Power Products, Div. of Computer Products ... 323
Powertec, Inc. ... †361
Practical Automation Inc. ... 282
Pecision Filters ... 155
Publicitas SA ... 400
RCA ... 238, 250
Racal Recorders Ltd. ... 276-277
Racal-Vadic ... 312
Reacor, Inc. ... 394
Relational Memories Systems ... 45, 390
Renaissance Systems ... 395
Reticon, EG&G ... 294
Rockwell International ... 231
Rogers Corporation ... 345, 391
Rolm Corporation ... 167
SGL Homalite ... 391
Sams & Co., Inc. Howard ... 369
Sangamo Capacitors, A Div. of Sangamo Weston Inc. ... 230
San-O Industrial Corp. ... 289
Seitz SA ... 140
Shugart Associates ... 139
Siemens Corporation ... *54D, †338-339, †367
Sierracin Corp. ... 232
Signal Transformer Co., Inc. ... 358
Sodeco, Landis + Gyr, Inc. ... 279
Sola Electric ... 80
Solid State Scientific, Inc. ... 153
Solitron Devices, Inc. ... 212
Spectronics, Incorporated ... †342
Spirig ... 395
Sprague Electric Company ... 48, 204
Stacoswitch, A Staco Inc. Company ... 307
Statek Corp. ... 194
Stevens Tubing Corp. ... 393
Sun Research ... 393
TRW/IRC ... 23
TRW/LSI Products ... 203
Taurus Corp. ... 393
Tecknit, EMI Shielding Div. ... 94
Tektronix, Inc. ... 51, 96, 320-321, 353
Teledyne Crystalonics ... 395
Teledyne Philbrick ... 284
Tempil Division ... 390
Texas Instruments, Incorporated ... 311, 313, 335
Thermosen, Inc. ... 400
Topaz-Power Mark Inc. ... 370
Topaz Electronics ... 370
Toyo Communication Equipment Co., Ltd. ... 360
Triple I Inc. ... 306
Turner Designs ... 394
Unimax Switch Corporation ... 182
Universal Instruments ... 34
Vero Electronics, Inc. ... †368
Victory Engineering Corp. ... 286
Viking Connectors,Inc. ... †365
Wakefield Engineer, Inc., EG&G ... 274
Wall Industries ... 393
Wavetek Indiana Incorporated ... 3
Welco Industries, Inc. ... 371
Wells Electronics Inc. ... 316
Wes-Con Products Inc. ... 274, 325
Westrex OEM Products ... 282
Wintek Corporation ... 396
Xycom ... 92-93
Zenith Radio Corp. ... 198

Recruitment

The Aerospace Corp. ... 399
Allen-Bradley ... 384 A-B
Boeing ... 389
Computer Peripherals, Inc. ... 380
Coulter Electronics, Inc. ... 378
Digital Equipment Corp. ... 377
Electro-Pacific, Inc. ... 388
Emerson Electric Co. ... 388
GCA ... 382
General Dynamics (Pomona Division) ... 375
Hughes Aircraft Co. (Ground Systems) ... 383
ITT (Avionics) ... 385
ITT (North) ... 381
Litton Systems, Inc. (Amercom Division) ... 378
Lockheed Missiles & Space Co. ... 376
Mantech International Corp. ... 382
Modular Computer Systems, Inc. ... 386
NC ... 387
Northrop ... 380
RCA ... 384
Robins Air Force Base ... 374
Sperry Microwave ... 382
The Trane Company ... 374
Vought Corporation ... 379
Wallach Associates ... 380

†Advertisers in U.S. Edition
*Advertisers in Non U.S. Edition

“The works of Maria Goeppert Mayer are masterpieces of clarity and concreteness.”

-World renowned scientist Eugene Wigner

ARIA Goeppert Mayer was the first American woman to win the Nobel Prize haring the honor in 1963 with J. Hans Jensen and ugene Wigner for their contributions in nderstanding nuclear shell structure.

The recognition given Maria was unique in a me when the scientific world downplayed the chievements of women. Today, innovative women nd men at The Aerospace Corporation have an ctive voice in shaping the company's policies.

The Aerospace Corporation is a private, onprofit company dedicated to national security eeds. Aerospace specializes in space systems and elated technologies. The company provides eneral systems engineering and integration upport principally to the Air Force, but also for ational security-related programs.

Activities at The Aerospace Corporation are oncentrated in three technical divisions—the ngineering Group, the Programs Group, and the evelopment Group. Career opportunities in these roups exist in the following areas:

ELECTRONICS/ELECTRICAL

Radar Systems Analyst
Digital Systems
LSI Design & Circuit Analysts
LSI Specialist
Microwave Research Scientist/Engineer
Radar Systems Engineers
Electronic Circuits Analysts
Electrical Systems Test
ECM Systems
Spacecraft Systems

COMMUNICATION/TELEMETRY

Communications Systems Engineers
Communications Systems Analysts
Positions available in both Los Angeles and San Francisco Bay area.
Command and Telemetry Engineers
Satellite Borne Communications
RF Systems
Data Communications Systems
Positions available in both Los Angeles and San Francisco Bay area.
Communication Technology
TT&C Systems

COMMUNICATION/SATELLITE

Traveling Wave Tube Amplifier Engineers
RF Engineers
Spaceborne Digital Electronics
Satellite Integration and Test
Electrical Circuit Engineers
TT&C and Power

RELIABILITY

System Effectiveness Engineers
Space Electronics Product Design Engineers
Component Engineers
Product Assurance Engineers
Reliability/Maintainability Systems Engineers

OPTICS

Optics & Material Properties
Optical Systems Design Specialists
Infrared Optical Systems Engineers
Infrared Detector Specialists
Electro-Optical Systems Analysts

You'll like it here at The Aerospace Corporation. We offer an excellent salary and benefits program including fully paid medical and dental insurance, full tuition reimbursement, seven year vesting retirement program, tax-deferred savings plan, 3 weeks vacation your first year and 4 weeks after 3 years.

Successful candidates should have a minimum of a BS in Engineering/Science and at least four years of recent directly related experience.

Qualified individuals are invited to forward resume with salary history and salary requirements to:

Professional Placement
Box ED 510
2350 E. El Segundo Blvd.
El Segundo, CA 90245

The Aerospace Corporation
The Systems Architect/Engineer

U.S. Citizenship Required
Equal Opportunity Employer

Measure Light Directly in *Any* Optical Unit!

. . . Radiometric, Photometric or Specialized Measurements

IL700

- **UV, Visible & Infrared**
- **Sensitivities** from 10^{-15} to over 1.0 W/cm^2
- **Flash Measurement** Capabilities

Call Collect for Application Assistance and/or Custom Systems

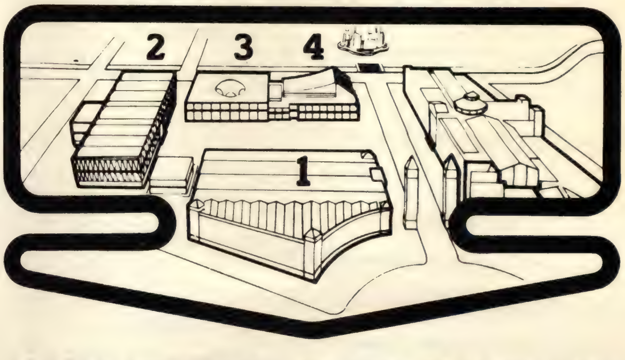
international light inc
Specialists in Light Measurement
DEXTER INDUSTRIAL GREEN, NEWBURYPORT, MASS. 01950
■ TEL. 617 465-5923 ■ TELEX 94-7135

CIRCLE NO. 209

sonimag 18

XVIII INTERNATIONAL IMAGE, SOUND AND ELECTRONICS SHOW

TO SEE AND HEAR



4 LARGE EXHIBITION PALACES DEALING WITH

1 Manufacturers of T.V., Radio, Hi-Fi Recording and play back equipment.

2 Components, Production Systems, Materials, Control Instruments, Security Systems, Communications (Professional, Radio hams).

3 Hi-fi, Sound and Vision, Recording, Musical Instruments and Spectacular lighting systems.

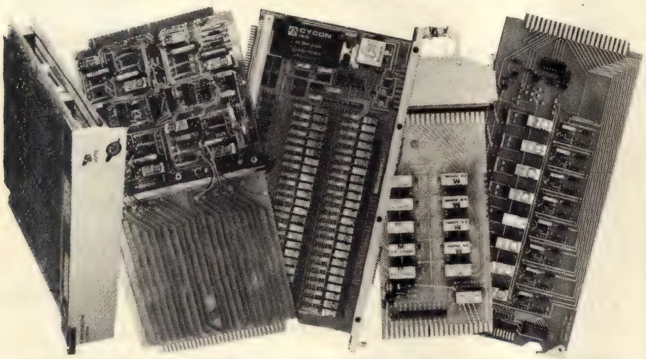
4 Symposiums, Conventions, Meetings. Hi-Fi and Video demonstrations.

FAIR GROUNDS: BARCELONA (SPAIN) 29th september, 5th october, 1980
Trade visitors: 29th, 30th september and 1st october - General Public: 2nd, 3rd, 4th and 5th october

INFORMATION: Avda. M.ª Cristina, s/n. - BARCELONA-4 (Spain) Tel. 223 31 01
Telex 50458 FOIMB-E

CIRCLE NO. 211

WHAT'S BEST FOR LOW-LEVEL SIGNAL SWITCHING?



THERMOSEN TYPE D RELAYS.

Our unique Type D relays are specifically designed to provide optimum performance in critical low-level switching applications. Useful in data acquisition systems, test instruments, and automatic testing equipment, they offer the advantages of low thermal emf, low dynamic noise, low stable contact resistance, high speed, long life/high reliability, excellent high frequency performance, very high insulation resistance, and true Form C switching. Maybe that's why they're specified so frequently to solve those really tough industrial, laboratory, and marine switching problems.

We've delivered hundreds of thousands of these Type D relays over the years. Why not let us tell you all about them? Write for our updated bulletin TR-4 today. We're Thermosen, Inc., 375 Fairfield Avenue, Stamford, CT 06904, (203) 324-6125.

MULTI REED THERMOSEN

CIRCLE NO. 210

NEW!

Abrasion Resistant* CRT Filters cuts glare & improves contrast.

- eliminate glare from ambient light
- exceptional angular viewing
- enhance contrast, improve sharpness
- interchangeable • selection of colors or neutral grays for all JEDEC sizes
- graticules available • low cost.

**Panelgraphic® 901 provides Steel Wool Resistant properties.*

PANELGRAPHIC CORPORATION
10 Henderson Drive • West Caldwell, New Jersey 07006
Phone (201) 227-1500; TWX: 710-734-4367

CIRCLE NO. 212

Articles I liked, disliked, would like: ______________________

FOR READER SERVICE, SEE OTHER SIDE.

Please Affix
Proper Postage
Post Office No
Longer Forwards
Unstamped Mail

ElectronicDesign

Hayden Publishing Co., Inc.
P.O. Box. 8308
Philadelphia, PA 19101
U.S.A.

VIA AIRMAIL

Please Affix
Proper Postage
Post Office No
Longer Forwards
Unstamped Mail

ElectronicDesign

Hayden Publishing Co., Inc.
P.O. Box 13803
Philadelphia, PA 19101
U.S.A.

VIA AIRMAIL

Articles I liked, disliked, would like: ______________________

FOR READER SERVICE, SEE OTHER SIDE.

Please Affix
Proper Postage
Post Office No
Longer Forwards
Unstamped Mail

ElectronicDesign

Hayden Publishing Co., Inc.
P.O. Box 8308
Philadelphia, PA 19101
U.S.A.

VIA AIRMAIL

ElectronicDesign READER SERVICE CARD

Use before 9/5/80

Area Code ☐☐☐ Office Telephone ☐☐☐-☐☐☐☐

10

1st/2nd Initial | Last Name | Title
Company Name (Do not abbreviate if possible)
Company Street Address | Internal Mail Code
Company City | Postal Code
County/Province | Country

Circle the **READER SERVICE** numbers in which you are interested.

1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300

301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	809	819
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	800	810	820
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	801	811	821
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	802	812	822
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	803	813	823
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	804	814	824
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	805	815	825
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	806	816	826
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	807	817	827
310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	808	818	828

This issue was ☐
was not ☐
addressed to me

No. of engineers
here ☐
(A) 1
(B) 2-5
(C) 6-19
(D) 20-49
(E) 50-99
(F) 100-249
(G) 250-499
(H) 500-999
(J) Over 1000

Date issue received
Mo. / Day / Yr.

SUBSCRIBE NOW

☐ ELECTRONIC DESIGN

A full year-26 big issues-of ELECTRONIC DESIGN now Jet Air Delivered to our international subscribers. Upcoming editorial features include Microprocessors, LSI Peripheral Chips, Logic Analyzers, Instruments '80, OptoElectronic Components, Readouts, Automatic Test Equipment plus many, many more. Your copies will be Jet Air Delivered to you anywhere in the world so that you will receive the latest electronics news and technology FAST. Subscription rates include Jet Air Delivery. Europe-$65; Mideast, North Africa, South America, Japan-$100; Central and South Africa, New Zealand, Australia and all other Asia-$130.

☐ Payment enclosed (US funds, please)
☐ Company Purchase Order enclosed. Bill company
☐ Bill me

☐ 1979 - 1980 GOLD BOOK

Off the press and now available for immediate delivery — the new edition of Electronic Design's GOLD BOOK. Improved, revised, updated, the new multi-volume edition places the entire international electronics industry at your fingertips. Be fully informed on U.S. and international electronics products — components — manufacturers — distributors — trade names — everything else you need to know for electronic purchasing and specifying. Order today at $45 per multi-volume set.

☐ Payment enclosed (US funds, please)
☐ Company Purchase Order enclosed. Bill company
☐ Bill me

10

Name ____________________
Company ____________________
Address ____________________
City/Province ____________________
Country/Postal Code ____________________

ElectronicDesign READER SERVICE CARD

Use before 9/5/80

Area Code ☐☐☐ Office Telephone ☐☐☐-☐☐☐☐

10

1st/2nd Initial | Last Name | Title
Company Name (Do not abbreviate if possible)
Company Street Address | Internal Mail Code
Company City | Postal Code
County/Province | Country

Circle the **READER SERVICE** numbers in which you are interested.

1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300

301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	809	819
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	800	810	820
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	801	811	821
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	802	812	822
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	803	813	823
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	804	814	824
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	805	815	825
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	806	816	826
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	807	817	827
310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	808	818	828

This issue was ☐
was not ☐
addressed to me

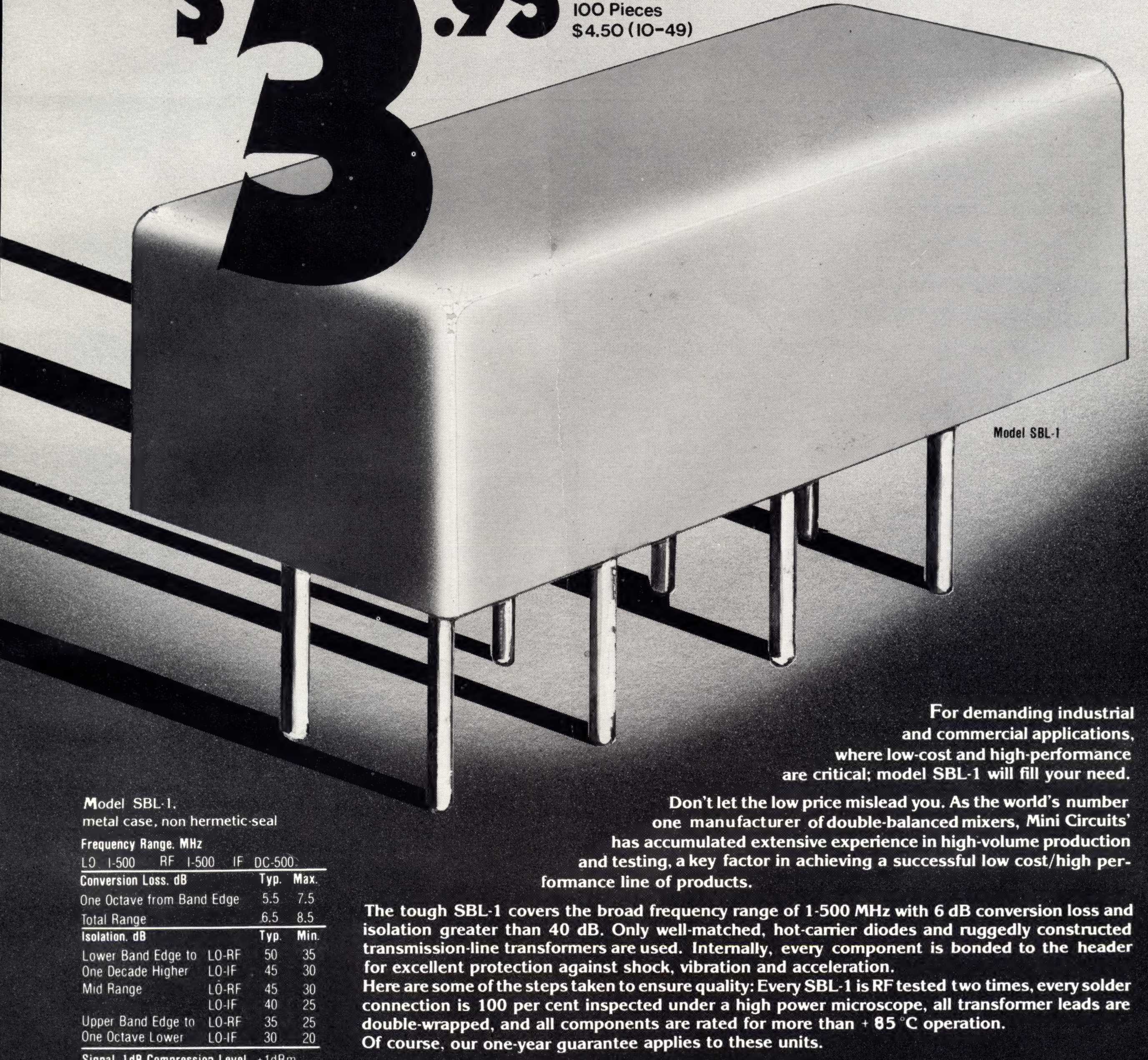
No. of engineers
here ☐
(A) 1
(B) 2-5
(C) 6-19
(D) 20-49
(E) 50-99
(F) 100-249
(G) 250-499
(H) 500-999
(J) Over 1000

Date issue received
Mo. / Day / Yr.

The most significant price breakthrough in DOUBLE-BALANCED MIXERS!

...from Mini-Circuits of course!

$3.95 100 Pieces
$4.50 (10-49)



For demanding industrial and commercial applications, where low-cost and high-performance are critical; model SBL-1 will fill your need.

Don't let the low price mislead you. As the world's number one manufacturer of double-balanced mixers, Mini Circuits' has accumulated extensive experience in high-volume production and testing, a key factor in achieving a successful low cost/high performance line of products.

The tough SBL-1 covers the broad frequency range of 1-500 MHz with 6 dB conversion loss and isolation greater than 40 dB. Only well-matched, hot-carrier diodes and ruggedly constructed transmission-line transformers are used. Internally, every component is bonded to the header for excellent protection against shock, vibration and acceleration.
Here are some of the steps taken to ensure quality: Every SBL-1 is RF tested two times, every solder connection is 100 per cent inspected under a high power microscope, all transformer leads are double-wrapped, and all components are rated for more than +85 °C operation.
Of course, our one-year guarantee applies to these units.

Model SBL-1.
metal case, non hermetic-seal

Frequency Range. MHz
LO 1-500 RF 1-500 IF DC-500

Conversion Loss. dB		**Typ.**	**Max.**
One Octave from Band Edge		5.5	7.5
Total Range		6.5	8.5
Isolation. dB		**Typ.**	**Min.**
Lower Band Edge to One Decade Higher	LO-RF	50	35
	LO-IF	45	30
Mid Range	LO-RF	45	30
	LO-IF	40	25
Upper Band Edge to One Octave Lower	LO-RF	35	25
	LO-IF	30	20

Signal. 1dB Compression Level +1dBm
Impedance. All Ports 50 ohms
Electronic Attenuation Min (20mA) 3dB

World's largest manufacturer of Double-Balanced Mixers

Mini-Circuits
MINI-CIRCUITS LABORATORY
A Division of Scientific Components Corp

2625 East 14th Street Brooklyn, New York 11235 (212) 769-0200
Domestic and International Telex 125460 International Telex 620156

21 Rev H BI

CIRCLE NO. 132

The trimmer gourmet's choice.

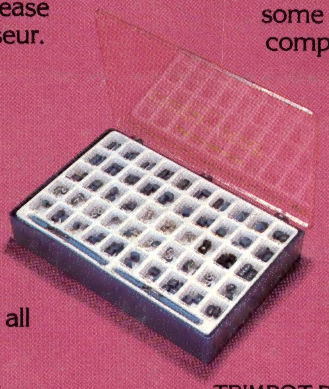
Feast your eyes on Bourns Trimpot® trimmers – the choicest and broadest trimmer line anywhere. A banquet of trimmers with outstanding quality and performance at cost-effective prices to please the most discriminating design connoisseur.

Le Plus Grand Menu

Rectangular, square or round
Sealed or open-frame
Wirewound or cermet
Single or multi-turn

Select the size, shape, type of element and method of adjustment to suit your taste. They're served in an assortment of resistance values and pin styles to satisfy all of your design needs.

Bourns is dedicated to serving all of your trimmer requirements . . . both now and in the future. Look for future innovations in downsizing, increased performance and cost-effective improvements. We're working on design solutions today for your application needs tomorrow.



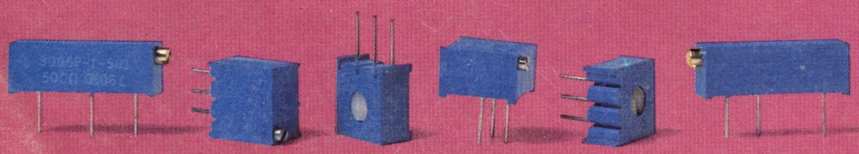
Introducing the Trim Bin™ Trimmer Kit. Here are some appetizers to tantalize your trimmer palate: A complete assortment of the most popular Trimpot trimmers and MFT™ trimmers/resistors in a convenient package for just $99.95*. A value of over $200, the kit contains 127 parts representing 50 varieties of resistances and pin styles, plus adjustment tools and design aids. It's available from your local Bourns distributor.

Vive la Résistance! Call your Bourns representative or distributor for more information and for your new 94-page TR-1 trimmer catalog.

TRIMPOT DIVISION, BOURNS, INC., 1200 Columbia Avenue,
Riverside, CA 92507. Ph: 714 781-5320. TWX: 910 332-1252.

European Headquarters: Bourns AG, Zugerstrasse 74 6340 Baar,
Switzerland. Ph: 042 33 33 33. Telex: 78722.

*Domestic U.S.A. price only.



The last word in resistive components

BOURNS®

For Immediate Application—Circle 130 For Future Application—Circle 230